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Pratt & Whitney Aircraft
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SPECIFICATION NO. 2698A
8 AUGUST 1966

JTF17A-21L TURBOFAN ENGINE SPECIFICATION

(COMPETITIVE DATA)

JAN 9 - 1967

Pratt & Whitney Aircraft DIVISION OF UNITED AIRCRAFT CORPORATION
FLORIDA RESEARCH AND DEVELOPMENT CENTER

№ 356 A

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Continued)

APPENDIX A

Flight Test Status Engines

PRATT & WHITNEY AIRCRAFT
Division of United Aircraft Corporation
East Hartford, Connecticut, U.S.A. 06108

Commercial
T.C. No.

Specification No. 2698A

MODEL SPECIFICATION
ENGINE, AIRCRAFT, TURBOFAN
PRATT & WHITNEY AIRCRAFT
JTF17A-21L

1.0 SCOPE

1.1 Scope - This specification establishes design and performance requirements for the Pratt & Whitney Aircraft (P&WA) JTF17A-21L turbofan engine to be certificated in Phase IV of the Supersonic Transport Program. Significant differences in the design and performance of the Phase III Flight Test Status (FTS) engines for airplane flight testing are noted in Appendix A.

1.2 Specification Performance and Installation Drawing - The Specification Performance is presented in table I and table II and estimated performance throughout the complete engine operating envelope is presented in curve No. S-82, sheet 1. The Installation Drawing forms a part of this specification and is included herein.

2.0 APPLICABLE DOCUMENTS - The following publications were used as a guide in the preparation of this document and form a part of this document to the extent specified herein.

2.1 Government

2.1.1 FAR Part 1 - Federal Aviation Regulations "Definitions and Abbreviations," effective date 15 May 1962.

2.1.2 FAR Part 21 - Federal Aviation Regulations "Certification Procedures for Products and Parts," effective date 21 September 1965.

2.1.3 FAR Part 25 - Federal Aviation Regulations "Airworthiness Standards: Transport Category Airplanes," effective date 29 July 1965.

2.1.4 FAR Part 33 - Federal Aviation Regulations "Airworthiness Standards: Aircraft Engines," effective date 1 February 1965.

2.1.5 FAR AC No. 33-1 - Federal Aviation Agency Advisory Circular "Turbine-Engine Foreign Object Ingestion and Rotor Blade Containment Type Certification Procedures," effective date 24 June 1965.

2.1.6 FAR Part 45 - Federal Aviation Regulations "Identification and Registration Marking," effective date 20 April 1964.

2.1.7 MIL-STD-210A - "Climatic Extremes for Military Equipment," dated 2 August 1957.

2.1.8 MIL-STD-704 - "Electric Power, Aircraft, Characteristics and Utilization of," dated 6 October 1959.

2.1.9 MIL-E-5007C - "Engines, Aircraft, Turbojet, and Turbofan, General Specifications for," dated 31 December 1965.

2.1.10 MIL-S-7742A - "Screw Threads, Standard Aeronautical," dated 2 December 1959.

2.1.11 MIL-S-8879A - "Screw Threads, Standard Aeronautical," dated 8 December 1965.

2.2 Non-Government

2.2.1 PWA 522 (ASTM D-1655-65T, Jet A, A-1) - Pratt & Whitney Aircraft Specification" Fuel, Commercial Aircraft Turbine Engine," dated 5 November 1965.

2.2.2 PWA 521-B Type II - Pratt & Whitney Aircraft Specification "Lubricant, Aircraft Turbine Engine," dated 25 June 1963.

2.2.3 SAE ARP 681A - Society of Automotive Engineers, Aeronautical Recommended Practice, "Engine Performance Presentation for Use on High Speed Digital Computers," dated 1 February 1960.

2.2.4 SAE ARP 865 - Society of Automotive Engineers, Aerospace Recommended Practice, "Definitions and Procedures for Computing the Perceived Noise Level of Aircraft Noise," dated 15 October 1964.

2.2.5 SAE ARP 866 - Society of Automotive Engineers, Aerospace Recommended Practice, "Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity For Use in Evaluating Aircraft Flyover Noise," dated 31 August 1964.

2.2.6 SAE AIR 876 - Society of Automotive Engineers, Aerospace Information Report, "Jet Noise Prediction," dated 10 July 1965.

2.2.7 PWA FTDM 208 - Pratt & Whitney Aircraft Technical Design Memorandum, "Design Maintainability Checklist."

2.2.8 PWA FTDM 207 - Pratt & Whitney Aircraft Technical Design Memorandum, "Design Reliability Checklist."

2.2.9 PWA FTDM 210 - Pratt & Whitney Aircraft Technical Design Memorandum, "Design Safety Checklist."

3.0 TYPE AND DESCRIPTION - The JTF17A-21L is a twin-spool, axial-flow duct heating turbofan engine with a forward multistage fan (also serving as the low pressure compressor) driven by a multistage reaction turbine, and a multistage high pressure compressor driven by a single-stage reaction turbine. This engine is capable of continuous operation at conditions defined herein. The primary engine exhaust discharges through a fixed convergent-divergent nozzle. The engine incorporates a full length concentric fan discharge duct with a duct heater for augmentation. The duct heater discharges through a modulating, variable-area, convergent exhaust nozzle operated by the engine control and hydraulic systems. The combined primary and duct heater exhaust discharges into a variable-area divergent ejector nozzle which also functions as a thrust reverser and a noise suppressor. Detailed descriptions of engine components shall be presented in the Installation Handbook.

3.1 Installation

3.1.1 Dimension and Installation Drawing - The following drawing forms a part of this specification:

Engine Installation Drawing No. 2128101 dated 8 August 1966.

3.2 Dry Weight of Engine - The dry weight of the basic engine shall not exceed 9860 pounds. The total dry weight of the engine including special installation items shall not exceed 10,247 pounds. The total dry weight does not include the weight allowance required for cover plates and those brackets supplied with the engine that are to be utilized for the support of airframe equipment. Engine components included in the basic engine dry weight are as follows:

Fuel System Including Gas Generator Control, Duct Heater Control, and Fuel Pumps
Lubrication System Including Oil Tank and Fuel/Oil Coolers
Engine Ignition System Without Power Source
Variable-Area Duct Heater Exhaust Nozzle Including Control System
Windmilling Brake System (Aerodynamic)
Reverser-Suppressor Including Control System
Gas Generator Exhaust Gas Temperature and Pressure Probes
Provisions for Power Setting Instrumentation

Special installation features included in the total dry weight of the engine are:

Fuel Inlet Manifold
Power Takeoff Provisions Including Angle Gearbox and Decoupler
Centerline Bend of 5 degrees
Inlet Splitter Mounts
Environmental Control System Compressor Drive and Associated Hardware
Turbopump Discharge Diffuser
Single Point Radial Rear Mount
Right and Left Front Thrust Mounts
Front Mount Relocation
Nacelle to Reverser-Suppressor Fairing

3.2.1 Weight of Residual Fluids - The estimated weight of residual fluids remaining in the engine after operation and drainage is 40 pounds.

3.3 Engine Mounting - Engine mounting provisions and load limits shall be as specified on the Installation Drawing.

3.4 Requirements

3.4.1 Materials and Processes - Materials and processes used in the manufacture of the engine shall be of quality consistent with aircraft standards.

3.4.2 Standards

3.4.2.1 Parts - AN, MS, or AS standard parts shall be used unless they are determined by P&WA to be unsuitable for the purpose, and shall be identified by their standard part numbers.

3.4.2.2 Design Standards - MS, AND, and industry design standards shall be used unless they are determined by P&WA to be unsuitable for the purpose.

3.4.3 Parts List - The parts list for the engine which satisfactorily completes the certification test as modified by approved changes shall constitute the parts list for engines of the same model to be delivered.

3.4.4 Interchangeability - All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable with each other with respect to installation and performance, except that matched parts or selective fits will be permitted where required.

3.4.5 Accessibility - Those parts of the engine requiring line maintenance checking, adjustment, draining, or replacement shall be made accessible without engine teardown or removal of major parts, components or accessories as shown on the Installation Drawing.

3.4.6 Maintainability, Reliability, and Safety

3.4.6.1 Maintainability - The engine shall be designed for ease of servicing and maintenance in accordance with 2.2.7.

3.4.6.2 Reliability - Engine reliability considerations shall be as guided by 2.2.8.

3.4.6.3 Safety - Engine safety considerations shall be in accordance with 2.2.9.

3.4.7 Engine Expansion Dimensions - Engine dimensional changes resulting from temperature increases between room and operating temperatures are as shown on the Installation Drawing.

3.4.8 Flight Maneuver Forces - The engine and its supports shall withstand without permanent deformation the conditions specified on the maneuver load diagram shown on figure 1. These conditions are based on the total dry weight of the engine specified in 3.2.

3.4.9 Ground Handling - The engine shall have provisions for ground handling attachments. The attachment provisions shall be designed for the following limit loads:

a. Vertical loading - 4 "g"
b. Side loading - 2 "g"
c. Fore to aft loading - 1.5 "g"

3.4.10 Engine Inlet Flange Design Load - The engine inlet flange design load shall be as specified on the Installation Drawing.

3.4.11 Containment and Rotor Structural Integrity - The engine shall be designed for rotor blade containment to meet the requirement of Paragraph 33.19 of Reference 2.1.4 and compliance shall be specified in the engine type certificate. Failsafe designs shall be incorporated with the objective of eliminating the possibility of catastrophic failure. Particular attention shall be given to the following:

a. The integrity of turbine and compressor disks with the objective of having blades fail first under overspeed or overtemperature malfunctions.

b. The integrity of shafts connecting compressors to turbines such that bearing or lubrication failure shall not cause parting or decoupling of the shaft.

c. To provide necessary margin for rotor structural integrity, the compressor, fan and turbine rotors shall be of sufficient strength to withstand the following abnormal conditions:

(1) Rotor speeds at 120% of maximum allowable speed on representative disks (compressor and turbine) at maximum allowable disk temperatures and gradients for 5 minutes.

(2) Measured gas temperature at least 75°F (41.7°C) in excess of the maximum allowable measured gas temperature and at maximum allowable speed for 5 minutes.

3.4.12 Flammable Fluid Systems - All external lines and fittings which convey flammable fluids shall be fireproof as defined in 2.1.1. Each separable joint or connection shall be designed so that likelihood of leakage causing a fire hazard is remote.

3.4.13 Engine Connections - All electric, fluid and pneumatic connections to which the airframe manufacturer will attach are defined on the engine Installation Drawing.

3.4.14 Connection Identification - Insofar as is practical, the engine shall be permanently marked to indicate all airframe connections shown on the Installation Drawing for instrumentation, electrical, fluid and pneumatic connections. Similar fluid connections located in close proximity to each other shall be made physically noninterchangeable.

3.4.15 Engine Mounted Airframe Accessories

3.4.15.1 Use of Integral Oil Systems for Accessories - The integration of accessory oil systems with that of the engine shall not be acceptable.

3.4.15.2 Engine-Supplied Support Brackets for Airframe Accessories - Engine-supplied support brackets for airframe accessories shall be as shown on the Installation Drawing. Support of airframe equipment shall be coordinated with and agreed upon by P&WA.

3.4.15.3 Cover Plates - Cover plates for covering all accessory drive openings where the accessory is not mounted for engine shipment shall be supplied with each engine. Suitable provisions for covering or plugging all other connection openings shall be made. Cover plates suitable for flight operation shall be provided on drive pads and connecting points which are not used.

3.4.16 Useful Life - The engine shall be designed for a useful life, including repair, consistent with an airplane normal service life expectancy of at least 50,000 hours. The design objective for the basic engine shall be a useful life, without repair, in excess of 5000 hours. P&WA shall undertake the design and development of improved components or parts and/or repair procedures for the components or parts, as shown to be required by airline service.

3.4.17 Identification of Product - The identification data applied to the engine data plate shall be in accordance with 2.1.6 as follows:

Manufacturer's Name or Trademark
Model Designation *
Serial No. *
Installation Arrangement *
Takeoff Rating *
Fuel *
Type Certificate Number *
Production Certificate Number *

* Applicable data to be entered by P&WA.

Equipment, assemblies and parts shall be marked for identification in accordance with P&WA standard procedures.

4.0 MASS MOMENT OF INERTIA OF ROTATING PARTS - The estimated effective mass moments of inertia of the engine rotors about their axes are 30.0 slug-feet squared for the low rotor and 21.5 slug-feet squared for the high rotor. The maximum effective mass moment of inertia of the engine at the power takeoff accessories drive is as shown on curve No. S-82, sheet 20.

4.1 Engine Mass Moment of Inertia - The engine mass moment of inertia shall be as specified in the Installation Handbook.

5.0 VIBRATION - The engine shall be designed and constructed to function throughout its operating range without inducing excessive stress in any of the engine parts because of vibration. The engine unbalance shall not cause an engine case displacement greater than ± 3 mils. This vibration requirement is applicable to engines operating with specified flight weight components installed. Installed vibration characteristics of the engine-nacelle combination must be established by the airframe manufacturer and be coordinated with P&WA.

5.1 Airframe Vibration Testing with Installed Engines - If the airframe manufacturer deems it necessary to shake the airframe with the engine installed during airframe stress and fatigue tests, or during tests to establish vibration characteristics, it will be necessary to rotate both engine rotors to prevent brinelling of the bearings. Rotor speeds may be achieved by turning the high rotor with a hydraulic starter or the low rotor with an air stream directed on either the turbine or fan blades. The determination of safe rotor speeds must be coordinated with and agreed upon by P&WA.

6.0 ENGINE PERFORMANCE

6.1 Performance Ratings - The specified ratings are attainable on a P&WA test stand using a P&WA bellmouth inlet at 1962 U. S. Standard Atmosphere (Geometric) conditions at the engine inlet and including correction to engine performance for any bellmouth total pressure loss. The specified engine thrusts and thrust specific fuel consumptions (TSFC) include the effects of the reverser-suppressor as shown on the Installation Drawing when operating in a free flow field with the flow axis parallel to the reverser-suppressor axis. This performance is based on a temperature corrected secondary airflow (W_{sc} defined below) of 2%, unless otherwise specified, except for reverse thrust which is based on zero secondary flow. A minimum of 2% corrected flow is required at all operating conditions when the tertiary and reverse doors are closed.

$$W_{sc}\% = \frac{W_s}{W_{ge} + W_{gd}} \left[\sqrt{\frac{T_{t2} + \Delta T_s}{\left(\frac{W_{ge} T_{t9} + W_{gd} T_{td}}{W_{ge} + W_{gd}} \right)}} \right] \times 100$$

where:

W_s = secondary airflow, lb/sec

W_{ge} = total gas generator gas flow at nozzle throat, lb/sec

W_{gd} = total duct gas flow at nozzle throat, lb/sec

T_{t2} = compressor inlet total temperature, °R

ΔT_s = secondary stream temperature rise, °R

T_{t9} = total temperature at gas generator nozzle throat, °R

T_{td} = total temperature at duct nozzle throat, °R

The specified reverse thrust is attainable at sea level static test stand conditions when reingestion of exhaust gases is not experienced, and without special restrictive provisions for reverse targeting. The specified value is based upon a reverse effective flow area over 198 degrees of circumference and a mean gas discharge angle of 20 degrees or less with the exhaust nozzle centerline.

6.1.1 Guaranteed Standard Day Calibration Stand Performance at Sea Level - The guaranteed steady-state performance ratings at static, sea level, standard day conditions are as shown in table I for a complete production engine including the reverser-suppressor when operating on a fuel specified in 2.2.1, without compressor airbleed or load on accessory drives other than that required for continuous engine operation.

Table I. Guaranteed Standard Day Calibration Stand Performance at Sea Level

Rating	Net Thrust (min), lb (4)	TSFC (max), lb/hr/lb (7)	Estimate of Measured Exhaust Gas Temp. (max), °F (°C) (5)	Estimated Airflow, lb/sec	Secondary Airflow, lb/sec	Esimated Engine Rotor Speed, rpm (5) N_1	N_2
Takeoff (1)							
Augmented	60,760(6)	1.78	1515 (823.9)	687	0	6500	8200
Non-augmented	38,130	0.75	1515 (823.9)	687	0	6500	8200
Maximum (2)							
Augmented	60,760(6)	1.78	1515 (823.9)	687	0	6500	8200
Maximum (3)							
Reverse	15,300	—	— —	—	-	—	—

(1) Takeoff Rating - This rating is intended for takeoff use only and is time limited to 5 minutes. The specified takeoff rating is the maximum takeoff thrust available at standard day temperatures and below.

(2) Maximum Rating - This rating is primarily intended for climb and acceleration with augmentation from zero to full duct heat. This rating is time limited to 30 minutes. This rating is also available for emergency use at the discretion of the pilot and is authorized as a maximum continuous rating under emergency conditions.

(3) The specified maximum reverse thrust is as measured along the exhaust nozzle centerline and is time limited to 1 minute.

(4) Forward thrust is measured along the exhaust nozzle centerline.

(5) Subject to change prior to engine certification.

(6) This value is 61,000 pounds when the exhaust system secondary corrected airflow is 2%.

(7) Based on fuel having a lower heating value of 18,400 Btu/lb.

6.1.1.1 Demonstration of Calibration Stand Performance - Engine performance of table I will be demonstrated using a production engine with the reverser-suppressor and P&WA bellmouth inlet.

6.1.2 Guaranteed Steady-State Performance Ratings at Standard Altitude Conditions - The guaranteed steady-state performance ratings at standard altitude conditions are as shown in table II for a complete production engine including the reverser-suppressor when operating on fuel specified in 2.2.1 without compressor air bleed or load on accessory drives other than that required for continuous engine operation, and with simulated distortion patterns which are representative of the airframe manufacturer's inlet but not to exceed those of 10.0. Performance in terms of the airframe manufacturer's ram recovery and secondary airflow rate is shown in table IIA.

6.1.2.1 Demonstration of Altitude Performance - Engine performance of table II will be demonstrated using a production engine or an engine assembled substantially in accordance with the production parts list on a P&WA approved test stand using the specified fuel and standard calibration equipment and methods. The substantiation of any guaranteed point where the test conditions exceed the capability of the laboratory will be by calculations from test data obtained at test conditions that lie within the capacity of the laboratory.

Engine performance will be demonstrated by calibrations without the reverser-suppressor. Reverser-suppressor gross thrust coefficients (C_{fp}) determined from isolated scale model tests in a free flow field with a uniform and parallel flow forward of the tertiary doors, will be applied to the ideal expansion gross thrust to obtain the actual gross thrust. Simulated flight Mach number and altitude conditions will be accomplished by setting measured test engine inlet total pressure and total temperature corresponding to that calculated for the 1962 U. S. Standard Atmosphere (Geometric) and the specified inlet ram recovery. Engine airflow will be measured using a standard ASME orifice to permit the calculation of ram drag and gross thrust. Measurements of engine discharge pressures, temperatures, and areas, combined with ambient back pressure for the simulated altitude, permit calculation of gross thrust assuming an ideal expansion process to ambient pressure.

Net thrust is determined by subtracting the calculated ram drag (of the engine plus secondary airflows) from the calculated gross thrust. The specified TSFC is obtained by dividing the measured engine fuel flow by the net thrust.

For the purpose of practical demonstration, the altitude performance will be met if substantiated within the precision of the altitude laboratory equipment.

6.2 Estimated Engine Performance - Estimated engine performance and data are shown on curve No. S-82, sheets 1 through 33. Information supplied on these curves is based upon no air bleed and no power extraction over and above that required for continuous operation of the engine and accessory drives, except as specified.

A card deck program, reference curve No. S-82, sheet 1, shall be provided which is capable of running on a highspeed computer mutually agreed upon by P&WA and the airframe manufacturer. This program will define estimated engine performance, representing maximum fuel flow, minimum thrust and average values for all other items, and will be consistent with the engine performance specified in table I and table II. Idle thrust may be average. The program shall be capable of generating data at any power setting from idle to takeoff at any altitude, Mach number, or ambient temperature within the engine operating envelope. The program shall be capable of making corrections for horsepower extraction, inlet pressure recovery and air bleed.

Unless otherwise specified, all engine performance estimates are based upon the following:

a. Ambient conditions in accordance with 1962 U. S. Standard Atmosphere (Geometric).
b. Inlet total pressure recovery at the engine inlet as defined in curve No. S-82, sheet 5.
c. Radial and circumferential overall pressure distortion at the engine inlet as defined in section 10.0 (a).
d. Fuel with a lower heating value of 18,400 Btu/lb.
e. No power extraction or compressor air bleed over and above that necessary for operation of engine accessories and drives.
f. Minimum effective flow area for reverser-suppressor tertiary air induction of 12.0 square feet over a minimum circumference of 242 degrees.
g. Thrusts are along the exhaust nozzle centerline.

6.3 Flight Conditions - The engine shall function satisfactorily under the following flight conditions:

a. Level position (horizontal) with the engine inclined (roll) 20 degrees to either side.
b. Level position (horizontal) with the engine inclined (roll) 45 degrees to either side for 30 seconds.
c. Zero to 15 degrees below horizontal (nose down) with up to 20 degrees inclination on either side.

Table II. Guaranteed Steady-State Performance Ratings at Standard Altitude Conditions

Power Setting	Pressure Altitude, ft	Mach No.	Ram Recovery	Net Thrust (Min), lb (1)	TSFC (Max), lb/hr/lb (6)	Estimate of Measured EGT (Max), °F (°C) (4)	Airflow, lb/sec ± 3%	Estimated Rotor Speed, rpm (4) N_1	N_2	Estimated Secondary Airflow, lb/sec (4) (5)	Estimated Secondary Stream Total Pressure, P_{ts}, psia (3) (4)
Maximum Augmented	45,000	1.2	0.991	19,900	1.86	1525(829.4)	250(4)	6510	8080	12.5	3.2
Cruise Partially Augmented	65,000	2.7	0.846	12,770	1.53	1450(787.8)	341(2)	5600	8250	10.0	2.8
Cruise Nonaugmented	36,150	0.9	1.0	5,010	1.07	940(504.4)	251(4)	5260	7030	7.0	3.3
Part Power	15,000	0.5	1.0	4,580	1.06	745(396.1)	324(4)	4300	6450	8.3	8.3

(1) Thrusts are along the exhaust nozzle centerline.
(2) Cruise airflow steady state tolerance does not include tolerances due to inlet flow distortion.
(3) At the specific secondary airflow.
(4) Subject to change prior to engine certification.
(5) Secondary air at engine face.
(6) Based on fuel having a lower heating value of 18,400 Btu/lb.

Table IIA. Steady-State Performance Ratings at Standard Altitude Conditions

Mach No., M	0.5	0.92	0.42	0.45	1.2	2.7
Altitude, ft (Reference Only)	15,000	40,000	5000	5000	41,000	67,500
Ambient Pressure, psia	8.30	2.73	12.23	12.23	2.60	0.73
Ambient Temperature, °R	465	390	501	501	390	391
Compressor Inlet Pressure, psia	9.63	4.63	13.48	13.74	6.17	15.22
Compressor Inlet Temperature, °R	489	456	519	521	503	957
Nozzle Secondary Pressure, psia	8.55	3.37	12.34	12.43	4.36	4.27
Secondary Total Temperature, °R	489	456	519	521	528	977
Secondary Flow Ratio, W_s/W_2	0.055	0.064	0.033	0.045	0.067	0.057
Net Thrust, lb (2)	6300	6350	17,950	7000	23,670	13,450
Specific Fuel Consumption, lb/hr/lb	0.98	1.05	0.87	1.07	1.86	1.58
Airflow, lb/sec (± 3%) (1)	----	----	----	----	----	318

(1) Cruise airflow steady state tolerance does not include tolerances due to inlet flow distortion. Manual adjustment of approximately ± 6% to improve engine inlet match is provided.

(2) Thrusts are along the exhaust nozzle centerline.

d. Zero to 30 degrees above horizontal (nose up) with up to 20 degrees inclination on either side.
e. Flight operation under negative 1 "g" flight conditions for 10 seconds.
f. Flight operation under zero "g" flight conditions for 5 seconds.

6.4 Atmospheric Liquid Water - The engine shall operate satisfactorily throughout the flight operating envelope under conditions of idle to maximum thrust at levels up to 5% of the total airflow weight in the form of water (liquid and vapor) evenly distributed as it enters the engine inlet.

7.0 ENGINE OPERATING ENVELOPE - The engine shall operate satisfactorily within the inlet total temperature and total pressure limits as shown on curve No. S-82, sheet 2.

8.0 THRUST TRANSIENTS

8.1 Stability - Under steady-state operating conditions without augmentation, thrust oscillation shall not exceed ± 5% of the thrust available at that particular power lever position and flight condition, but in no event shall the thrust oscillation exceed ± 1% of the maximum nonaugmented thrust available. During steady-state operation with any amount of augmentation up to maximum, the engine thrust oscillation shall not exceed ± 1% of the maximum augmented thrust available at that condition.

8.2 Response - For power lever movement of 1 second or less, the time required to safely accomplish the following transients on a standard day with no bleed or power extraction shall not exceed the tabulated values, as installed in the aircraft, from sea level to 10,000 feet altitude:

Transient	Time, sec,
Idle to 75% maximum nonaugmented rating:	6.0
Idle to 95% maximum nonaugmented rating:	8.0
Idle to 95% maximum augmented rating:	8.5
30% maximum nonaugmented rating to 95% augmented rating:	5.0
Maximum augmented rating to 95% full reverse:	6.0
Maximum nonaugmented rating to 95% maximum augmented rating:	4.0
50% maximum nonaugmented rating to 95% maximum nonaugmented rating:	4.0

The relationship of engine high rotor speed versus time is shown on curve No. S-82, sheet 21.

8.3 Airflow Transients - Transient inlet and engine compatibility is dependent on complex inlet and engine operational response, stability, and distortion characteristics. Accordingly, transient compatibility between inlet and engine shall be developed by the inlet compatibility program shared by P&WA and the airframe manufacturer. P&WA and the airframe manufacturer will establish final inlet and engine transient tolerances on the basis of detailed analysis and inlet and engine development tests.

During supersonic inlet operation (inlet started), engine airflow transient changes at maximum nonaugmented and above are estimated to be less than ± 3% of engine inlet corrected airflow. For steady-state conditions, the rate of change shall not exceed 50% per second for airflow changes greater than 0.5%.

9.0 <u>PRESSURE AND TEMPERATURE CHANGE</u>

9.1 <u>Inlet Pressure Transients</u> - The engine is designed to be capable of experiencing an occasional reduction in stabilized $P_{t2\ Avg}$ of 60% in 1/10 of a second for a maximum of 2 seconds without any direct damage provided that the distortion limits specified herein are not exceeded. Rapid changes of pressure are not recommended and would be expected to cause adverse engine operation including stall and/or flameout.

The engine is designed to be capable of experiencing an occasional variation of stabilized $P_{t2\ Avg}$ of +15% and -60% at a frequency range of up to 10 cycles per second for a maximum of 1 minute without any direct damage provided that the distortion limits specified herein are not exceeded. Rapid changes in pressure are not recommended and would be expected to cause adverse engine operation including stall and/or flameout.

9.1.1 <u>Minimum Exhaust Pressure</u> - The engine inlet air total pressure divided by the external pressure at the exhaust nozzle shall not be less than 1.0 at high rotor speeds less than 6500 rpm in flight.

9.2 <u>Inlet Temperature Rate of Change</u>

9.2.1 <u>Normal</u> - The maximum continuous rate of inlet temperature change which the engine can withstand without performance degradation is 1.5°F (0.8°C) per second. The engine can withstand a rate of inlet temperature change not exceeding 5.0°F (2.8°C) per second for a total of 40°F (22.2°C) to account for atmospheric temperature gradients.

9.2.2 <u>Emergency</u> - Under emergency conditions, the maximum continuous rate of inlet temperature change shall not exceed 3.0°F (1.7°C) per second. It is anticipated that performance degradation will result from engine operation which exceeds the limits in 9.2.1 but does not exceed the emergency limit.

10.0 <u>INLET AIR PRESSURE DISTORTION</u> - The estimated capability of the engine to withstand inlet air pressure distortion is described below where terms are defined as follows:

$P_{t2\ Avg}$ = Average area weighted engine inlet total pressure

$P_{t2\ Max}$ = Maximum engine inlet total pressure measured using instrumentation as approved by P&WA and the airframe manufacturer

$P_{t2\ Min}$ = Minimum engine inlet total pressure measured using instrumentation as approved by P&WA and the airframe manufacturer

$$\text{Percent Overall Distortion} = \frac{P_{t2\ Max} - P_{t2\ Min}}{P_{t2\ Avg}} \times 100$$

The Percent Overall Distortion shall be evaluated as a time dependent quantity and is defined as the maximum instantaneous value of the quantity.

Inlet and engine compatibility is dependent on complex inlet and engine flow parameters including distribution and extent of circumferential and radial distortion. Accordingly, compatibility between inlet and engine shall be developed by P&WA and the airframe manufacturer inlet compatibility program. P&WA and the airframe manufacturer will establish final inlet and engine distortion tolerances on the basis of detailed analysis and inlet and engine development tests and the estimates below must be considered as preliminary and subject to change. Until engine development confirms that adverse effects of distortion within these limits on engine performance and component durability are tolerable, flight operation at these distortion levels cannot be recommended.

a. For continuous operation, the estimated allowable overall inlet air pressure distortion limits as defined in 10.0 shall be approximately 13% except within 1/2 inch at the inside diameter and outside diameter of the flow annulus. The effect of distortion on engine performance within this limit may be considered negligible.

b. It is estimated that overall distortion of 25% excluding the area within 1/2 inch of the duct walls will not so adversely affect engine operation as to precipitate engine stall or flameout.

c. If all P&WA operating recommendations are followed, no direct engine damage would be expected as a result of inlet distortion in excess of above limits, if this distortion does not exceed a 10-second duration.

11.0 INLET ANTI-ICING - The engine shall be capable of operation througout the flight power range without accumulation of ice on the engine air induction system such as to adversely affect engine operation or cause a serious loss of thrust in continuous maximum and intermittent maximum icing conditions as defined in Appendix C of 2.1.3.

12.0 FOREIGN OBJECT INGESTION - The engine shall comply with the requirements of 2.1.5 with respect to foreign object ingestion. Demonstration of sheet ice ingestion shall be limited to single sheets of ice 1/2-inch thick and 144 square inches in area, and a single sheet of ice 1 inch by 2-1/2 inches by 30 inches having a specific gravity of 0.85 which is typical of ice formation at the airframe inlet.

13.0 EXHAUST SYSTEM

13.1 Secondary Airflow - Secondary airflow is required for reverser-suppressor cooling when the tertiary air doors are closed to control the expansion of the fan exhaust stream. The secondary air is supplied to and routed around the engine in accordance with the requirements of 6.1.

14.0 LUBRICATION SYSTEM - The lubrication system is a self-contained engine system which does not require an airframe supplied input.

14.1 Oil Type - The oil type is as specified in 2.2.2.

14.2 Oil Consumption - The oil consumption shall not exceed 0.25 gallons per hour as measured over a 10-hour period.

14.3 Oil Pressure and Temperature Limits - The operating oil pressure at maximum rated thrust shall be 45 ± 5 psi (relative to internal engine scavenge compartment) at 250°F (121.1°C) oil temperature. The oil pressure and temperature indicator ranges required for the cockpit indicators are 0 to 120 psi and 0 to 235°C, respectively. The maximum transient oil temperature during normal operation shall be 360°F (182.2°C) at the location indicated for oil temperature on the Installation Drawing. During windmilling operation up to 25% of maximum rated engine rotor speed, the maximum transient oil temperature shall not exceed 400°F (204.4°C) for 3 minutes and the oil pressure must be positive. Low temperature starting and operation is limited to an oil temperature corresponding to an oil viscosity of 10,000 centistokes.

14.4 Oil Quantity - The oil reservoir shall contain usable oil sufficient for 10 hours of engine operation.

14.5 Oil Tank - The oil tank shall contain the following features:

a. Gravity-fill port with scupper drain (at tank)
b. Quantity Measurements
   (1) Mounting boss for remote oil quantity transmitter
   (2) Dip stick and cap
c. Scavenge Oil Deaerator (with tank)
d. Drain Valve
e. Strainers on Supply Ports (pressure and gravity)
f. Magnetic Chip Detector.

14.6 Oil Flow Interruption - The engine shall operate continuously with no detrimental effects during and after a period of 10 seconds of negative "g" operation and/or 30 seconds of low oil pressure indication caused by maneuvers.

14.7 Drive Pad Lubrication - The power takeoff and tachometer pads shall be pressure lubricated by the engine lubrication system.

15.0 FUEL - The engine shall function satisfactorily throughout the operating envelope when supplied with aviation kerosene meeting the requirements of the fuel specified in 2.2.1 at the engine fuel inlet.

15.1 Fuel Temperature Limits - The temperature of fuel provided at the engine inlet connection must be between the limits shown below for the condition specified. The allowable time at the maximum fuel temperature limits is shown on curve No. S-82, sheet 22.

Table III. Fuel Temperature Limits

Condition	PWA 522 (Jet A, A-1)
Ground Starting	Minimum - Temperature corresponding to a fuel viscosity of 12 centistokes.
	Maximum - Curve No. S-82, sheet 23.
All Other Conditions	Minimum - 10°F (5.6°C) above fuel freezing point.
	Maximum - 260°F (126.7°C) or as shown on curve No. S-82, sheet 23.

The temperature rate of change at the engine fuel inlet connection shall not exceed 50°F (27.8°C) per minute. Provisions have been made on the engine to measure pressure drop across the fuel filter as an indication of ice accumulation. The engine is not equipped with a fuel heater, therefore, the airframe system must be capable of increasing the fuel temperature to prevent ice formation.

15.2 Fuel Pressure Limits - Fuel pressure, including cyclic and random pressure fluctuations, at the engine connection must be maintained at not less than 5 psi above true vapor pressure of the fuel and not greater than 50 psig and with a vapor/liquid ratio of zero. Fuel pressure at the engine connection may be greater than 50 psig but shall not exceed 75 psig at fuel flows below 15,000 pounds per hour (pph). Pressure fluctuations at the engine fuel pump inlets shall be within the limit of curve No. S-82, sheet 24.

Under emergency conditions, with tank-mounted boost pumps inoperative, the engine fuel system shall supply the required amount of fuel for engine operation from sea level to 80,000 feet altitude for a period not to exceed 4 hours during a flight, including air starting and augmentation, provided that: (a) the fuel temperature at the engine inlet does not exceed those limits specified in 15.1; and (b) the fuel vapor/liquid ratio at the engine connection does not exceed 0.45.

The engine fuel system shall be capable of priming itself and starting within 2 minutes after fuel runout when subjected to the following conditions provided a suitable line from the gas generator fuel pump discharge vent, as shown on the Installation Drawing, is installed:

a. Dry lift of 4 feet.
b. 20,000 feet fuel tank altitude.
c. 140°F (60°C) fuel temperature.
d. A dry line volume of 5 U. S. gallons maximum between the fuel pump inlet and the fuel pump supply.
e. Fuel as specified in 2.2.1.

15.2.1 Fuel System Design Pressure - The engine fuel system shall be designed to withstand a maximum fuel pressure of 125 psig applied at the engine inlet connection with the engine shutdown.

15.3 Fuel Recirculation - The engine will provide a connection for the recirculation of fuel to the aircraft tanks. The location and details of this connection shall be defined on the Installation Drawing. During operation where recirculation is not required, a continuous flow of 500 pph may be allowed for recirculation to prevent stagnation in the aircraft system. The pressure, flow, and temperature requirements at the engine fuel recirculation connection are shown on the Installation Drawing.

15.4 Fuel Cleanliness - Fuel delivered to the engine must meet the requirements of 2.2.1 and be free of all solid contamination larger than that which will pass through a 200-mesh screen and be essentially free of solid contamination of a smaller size.

15.4.1 Fuel Contamination - The use of fuel contaminated to the extent of 8 grams of foreign matter per 1000 gallons shall not inhibit satisfactory engine running for a minimum of 10 hours. This foreign matter shall be considered to consist of not less than 66% SiO_2 and shall have a particle size analysis as follows:

Particle Size, Microns	Percent of Total by Weight
0 - 5	39 ± 2
5 - 10	18 ± 3
10 - 20	16 ± 3
20 - 40	18 ± 3
Over 40	9 ± 3
Through a 200-mesh screen	100

15.4.2 Fuel Filters - The fuel filters shall be provided with the engine. Each shall be of sufficient capacity to permit a cumulative fuel flow equivalent to a minimum of 10 hours of continuous engine operation at maximum nonaugmented sea level thrust. This time is based on fuel contaminated as specified in 15.4.1 where the contaminated fuel has first passed through a 200-mesh screen prior to entering the fuel system.

15.5 Fuel Leakage - There shall be no leakage from any part of the engine except at the drains provided for this purpose. The combined liquid leakage from the overboard fuel drains shall not exceed 100 cubic centimeters per minute during engine steady operation.

15.6 Combustible Fluid Drains - Provisions shall be made for automatically clearing the combustion areas of combustible fluids after each false start and for preventing excess combustible fluids from entering the combustion areas after shutdown with the engine in a level position, 15 degrees nose up, and 20 degrees nose down. Provisions shall also be made for clearing all vent areas and other pockets or compartments where combustible fluids may collect during or subsequent to operation of the engine.

15.7 Fuel Flowmeter - The provision for installation of fuel flowmeters is noted on the Installation Drawing.

15.8 Fuel Flow Limits - The maximum fuel flow shall be 120,000 pph at maximum rating and takeoff operating conditions. The minimum fuel flow limit shall be 1200 pph at idle rating and cruise operating conditions.

16.0 ENGINE CONTROL SYSTEM - The fuel and exhaust nozzle control incorporates the gas generator and duct heater controls in a unitized assembly. The unitized control has dual input levers. The power lever controls engine thrust, speed, and turbine inlet temperature from Full Reverse to Idle to Maximum Augmentation. The shutoff lever provides for engine shutdown and starting by closing or opening the fuel shutoff valve. Fuel is metered to the gas generator to set the desired thrust as a function of power lever position, high compressor rotor speed, burner pressure and engine inlet temperature. Fuel is metered to the duct heater to set the desired thrust augmentation as a function of power lever position, burner pressure, and engine inlet temperature. The duct heater exhaust nozzle area is positioned to control total engine airflow over part of the engine operating range as shown on curve No. S-82, sheet 4. Remote manual power and airflow setting is provided to allow vernier adjustment. If engine speed exceeds a specified value, the gas generator fuel control automatically reduces fuel flow to prevent turbine overtemperature and damaging engine rotor speeds. Low rotor overspeed is limited by automatic derichment of gas generator fuel flow. The control system also provides reverser interlocks to: (1) prevent engine power requests not consistent with the reverser position; and (2) return the engine power to idle if the reverser inadvertently moves from the requested position.

The control system also provides the following auxiliary functions:

a. Positions the compressor stator vanes.
b. Positions the compressor bleeds.
c. Positions the reverser-suppressor.
d. Provides fuel shutoff.
e. Provides duct heater ignition.

The engine-driven gas generator fuel pump incorporates a centrifugal boost stage and a gear stage. A pressure relief valve is incorporated to bypass the boost stage in the event of pump drive malfunction, and a pressure relief valve is included from gear stage discharge to gear stage inlet to prevent fuel system overpressurization. The duct heater fuel pump is a centrifugal pump driven by a turbine driven by a high compressor discharge air, which is modulated by a pump controller in response to servo pressure signals from the unitized control. The turbine exhaust air passes through a vortex venturi which aerodynamically limits pump overspeed. The engine-driven hydraulic pump is a variable flow, constant pressure, piston-type pump.

16.1 Control Levers - A single power lever shall be provided on the engine to modulate thrust. The power lever shall have a total travel and dwell bands as shown on curve No. S-82, sheet 25. A separate lever with a total travel as shown on the Installation Drawing shall be provided for fuel shutoff and aerodynamic brake operation. There shall be stops and indexing provisions for the power lever and the shutoff lever as shown on the Installation Drawing.

16.1.1 Thrust and Power Lever Position Relationship - The design relationship between thrust and power lever position shall be of the fully modulated type, free of abrupt changes, and essentially linear (except when the bleed valve operates), with an instantaneous thrust increase of not more than 4% when augmentation is initiated or terminated. The design relationship between reverse thrust and reverse thrust power lever position shall be free of abrupt changes and essentially linear.

16.1.2 Control Lever Torque - The torque required for advancing or retarding the control levers shall not exceed 20 pound-inches with the engine operating at idle or above. Below idle, the torque required for advancing or retarding the control levers shall not exceed 50 pound-inches. The reverser interlock mechanism shall be capable of applying 300 pound-inches to the power lever, including control torque requirements, when returning it to the idle position.

16.2 Mechanical Connections - The maximum loads that may be applied to any control system mechanical connection are as shown on the Installation Drawing.

16.3 Control System Adjustment - External control system adjustments shall be clearly marked, accessible, and adjustable with the engine running. All other adjustments shall be protected to discourage tampering. The adjustments shall include the following.

16.3.1 Idle Speed - The idle speed shall be adjustable within a range of at least ±5% of the specified idle value with reference to the engine operating characteristics on the ground.

16.3.2 Duct Heater Fuel Flow - The maximum duct heater fuel flow shall be adjustable within a range of ± 5% with reference to the engine operating characteristics on the ground.

16.3.3 Airflow - Remote adjustment of airflow for optimum engine inlet matching is provided.

16.3.4 Gas Generator Pressure Ratio - Remote adjustment of engine pressure ratio is provided to allow close setting of engine power in the duct heater regime.

16.4 Environmental Temperatures - The engine components shall operate satisfactorily under the environmental temperatures anticipated at the following conditions:

a. Continuous operation with surrounding air at the maximum ram temperature of 575°F (301.7°C) and a velocity of 10 to 200 feet per second.

b. In-flight shutdown from the most adverse conditions and continued soaking with surrounding air at the maximum ram temperature of 575°F (301.7°C) and a velocity of 10 to 200 feet per second provided fuel recirculation is maintained.

c. Ground shutdown with surrounding air at the standard hot day conditions.

17.0 IGNITION SYSTEM - The ignition system consists of 2 fuel-cooled, hermetically sealed exciter packages each containing 2 independent exciter circuits for 1 gas generator igniter and 1 duct heater igniter. The ignition system is a capacitor discharge, 4 joule per spark at 3 kilovolts (with boost capability), intermittent duty, alternating current powered system.

17.1 Ignition System Performance - The engine start ignition system shall be capable of releasing sufficient energy for all ground and air starting requirements. The gas generator circuit shall supply a minimum of 1 spark per second and the duct heater a minimum of 5 sparks per second at the minimum voltage specified herein. The gas generator ignition system shall be capable of discretionary continuous operation.

17.2 Ignition System Power Source - The minimum power source and the maximum input to each exciter circuit shall be as specified on the Installation Drawing.

18.0 ELECTRICAL SYSTEM

18.1 Electrical Power - The effects of loss of electrical power to engine ignition or any additional equipment requiring external power, causing the equipment to be inoperative, shall not cause unsafe engine operation at any speed at or above idle throughout the complete thrust range except for potential effects of an inoperative ignition. Electrical equipment shall operate with power defined in 2.1.8.

18.1.1 External Electrical Power - External electrical power requirements shall be as specified on the Installation Drawing.

18.2 Electrical and Electronic Interference - Electrical and electronic components shall not cause interference beyond the limits specified in 2.1.9, figures 2 through 5. These components shall not be susceptible to interference generated by other electrical and electronic sources within the limits specified in table IV.

Table IV. Electrical and Electronic Interference

	Antenna	Frequency Range	Voltage	
Conducted interference	---	(rf) 0.15 to 1,000 mc(1)	0.1	(3)
		(af) 50 to 15,000 cps(2)	3.0	
Radiated inteference (4)	41 inch rod	0.10 to 25 mc	0.1	(3)
	35 mc dipole	25 to 35 mc	0.1	(3)
	tuned dipole	35 to 1,000 mc	0.1	(3)

(1) Applicable only to ungrounded line voltage power input points.
(2) Applicable only to ungrounded dc line voltage power input points.
(3) Modulated 30% at 400 to 1,000 cycles or any special form of modulation to which the equipment is vulnerable.
(4) Antenna placed 1 foot from electrical or electronic components.

18.2.1 Short Duration Interference - Short duration transients and impulse interferences are not to be considered as interference if their duration is less than 3 seconds and infrequent.

18.3 Ignition Explosion-Proof - All electrical components shall be ignition explosion-proof in order not to ignite any explosive mixture surrounding the equipment.

18.4 Connectors and Cable - At a temperature of -40°F (-40°C), it shall be possible to connect or disconnect electrical connectors and to flex electrical conductors, as necessary for routine maintenance, without damage to these items.

19.0 LIMITING ZONE TEMPERATURES - Airframe engine nacelle design shall be such that engine case temperatures shall not exceed those specified on curve No. S-82, sheet 26. The engine shall not require blast air cooling of the nacelle area. All components within this zone shall, by basic design, be suitable for operation (ground shutdown, flight shutdown, and all flight conditions) without added ram cooling, but with normal nacelle leakage unless local temperatures due to external heat sources, other than from the engine and its components, exceed the limits in 16.4.

20.0 STARTING - The fuel flow required for engine lightoff and acceleration to idle shall be automatically controlled when the fuel control shutoff lever is placed in the starting position with the power lever in the idle position. Automatic actuation of the starter or ignition system will not be provided. Appropriate starting torque shall be provided by a suitable airframe mounted starter through the power takeoff drive to the high speed rotor (N_2). The in-flight and ground starting requirements are as follows.

20.1 In-flight Starting - Starter assistance is not required to satisfactorily start the engine within the flight conditions shown on curve No. S-82, sheets 2 and 3 provided:

a. That the fuel temperature requirements of 15.1 are met.
b. That the fuel pressure requirements of 15.2 are met.

c. That the electrical power requirements of 18.0 for starting are met.
d. That there is no compressor air bleed or power extraction other than that required for continuous engine operation.

In-flight starting may be obtained at ram pressure ratios below the minimum ram pressure ratio line on the windmilling restart envelope by using engine starter assistance whenever the starter arrangement permits.

20.2 Ground Starting - The engine shall start satisfactorily within 60 seconds from fuel system pressurization in the sea level ambient temperature range from -40° to 103°F (-40° to 39.4°C) provided:

a. That the starting torque requirements shown on curve No. S-82, sheet 20 are met.
b. That the fuel temperature requirements of 15.1 are met.
c. That the fuel pressure requirements of 15.2 are met.
d. That the electrical power requirements of 18.0 for starting are met.
e. The engine inlet air total pressure divided by ambient pressure is not less than 0.99.
f. That the oil temperature requirements of 14.3 are met.

20.2.1 Unsatisfactory Start - After an unsatisfactory start the engine must be cleared of residual fuel by motoring the engine for a period of 30 seconds with fuel and ignition off. The restart can be attempted immediately after clearing the engine.

21.0 SHUTDOWN - Normal engine shutdown shall be accomplished by placing the power lever in the idle position and placing the shutoff lever in the "Fuel Off" position. Emergency engine shutdown shall be accomplished by placing the shutoff lever in the "Fuel Off" position with the power lever in any position. Shutdown of the duct heater shall be accomplished by placing the power lever in any position other than in the thrust augmentation range.

22.0 WINDMILL OPERATION

22.1 Windmilling Performance - Estimated steady-state windmilling engine performance is defined by curve No. S-82, sheets 6 through 19 and the following equation:

$$F_{nr} = F_{gr} - (1 + W_{sc})\, F_r$$

where:

F_{nr} = net thrust including reverser-suppressor effects

F_{gr} = gross thrust obtained from curve No. S-82, sheets 12 or 13 and δ_{t2}

W_{sc}* = ratio of secondary airflow to engine airflow

F_r = ram drag of engine airflow

δ_{t2} = compressor inlet face average total pressure in psia divided by 14.7 psia.

*Temperature corrected secondary flow ratio is the same as physical secondary flow ratio during steady state windmilling conditions since engine gas stream temperature is equal to secondary air temperature.

Necessary corrections must be applied during the performance calculation procedure to reflect the effects of customer air bleed and/or power extraction. The reverser-suppressor secondary flow ratio shall be determined from known characteristics of the nacelle secondary system to obtain the net windmilling thrust.

Upon completion of a calculation where customer power extraction is specified, the validity of the calculation must be checked by determining if the customer power extraction specified plus the engine accessory load and high rotor friction is within the limits indicated by curve No. S-82, sheet 16. This check may become iterative and affect earlier calculations. Should this result, the customer power extraction must be reduced and the calculation repeated until the limits shown on curve No. S-82, sheet 16, are observed.

23.0 REVERSE THRUST - The engine shall be capable of maximum reverse thrust operation within the envelope shown on curve No. S-82, sheet 27. The uninstalled estimated maximum reverse thrust is shown on curve No. S-82, sheet 28 for standard day operation and on curve No. S-82, sheet 29 for hot day operation when reingestion of exhaust gas is not experienced. This thrust is also based on a reverse effective flow area and a mean gas discharge angle with the exhaust nozzle centerline as specified in 6.1. The reverser is capable of maximum reverse operation within the reverser operating envelope for the time period specified in 6.1.1. However, continuous reverser operation at idle on the ground is allowable.

24.0 ENGINE NOISE LEVELS

24.1 Noise Levels - The noise levels generated by the engine aft of the engine exhaust plane and measured along the arc as shown on figure 2 shall not exceed the values shown in table V. Additional noise measurements will be recorded along the same arc of 300 feet radius at angles greater than 135 degrees. Noise levels measured at angles greater than 135 degrees shall not exceed the noise levels measured within the 90 degree to 135 degree measurement arc on figure 2 when all measurements are corrected to a line 300 feet from and parallel to the engine centerline. These noise levels shall be obtained during operation under the following conditions:

a. Static operation on an outdoor test stand.
b. P&WA bellmouth inlet.
c. Production engine or an acoustically similar engine.
d. Axis of reverser-suppressor parallel to ground.

Table V. Engine Noise Levels

Net Thrust, lb	Noise Level, PNdb
Maximum augmented	141
28,500 nonaugmented	126
28,500 augmented	124
22,400	118

24.2 Noise Suppression - The noise levels shown in table V include suppression of fan and jet noise based on experimental data. Exhaust noise is suppressed by 4 PNdb at the maximum augmented condition. For the 28,500 pound thrust level, the exhaust noise is suppressed 3 PNdb and the fan blade passing noise is suppressed 6 db per octave band. Exhaust noise is suppressed 3 PNdb and fan blade passing noise is suppressed 15 db per octave band for the 22,400 pound thrust level.

24.3 Optional Reduced Engine Rotor Speed Mode for Community Noise Abatement - Optional operation with the duct heater lit at intermediate thrust levels, such as those associated with the cutback after takeoff for community noise abatement, will result in reduced PNdb levels. This mode provides a reduction of fan rpm at constant thrust. At a thrust level of approximately 20,000 pounds the reduction in fan rpm permits improved fan frequency/resonator matching which can be expected to result in fan blade passing noise attentuation of approximately 13 db per octave band. Dependent upon the flight condition and engine thrust setting, this mode of operation will provide a further noise reduction of as much as 5 PNdb. The corresponding sea level static test stand demonstration of this mode of operation is shown in table V.

24.4 Sound Calculations - Measured octave band sound pressure levels will be converted to perceived noise values using the method prescribed in 2.2.4. All noise data will be normalized to 59°F (15°C) and 70% relative humidity using the method prescribed in 2.2.5. At least 6 test runs shall be made at each condition and the results averaged for demonstration purposes. If limitations during static test prevent the recording of noise at the conditions specified in section 24.0, the measurements will be taken at a suitable point and corrected to the specified distances. Correction of measured sound pressure levels to desired distances will be performed using the method prescribed in 2.2.6.

25.0 INSTRUMENTATION - The following shall be provided with the engine with connection provisions as shown on the Installation Drawing.

a. Turbine exit pressure probes and averaging manifold.
b. Instrumentation for providing an electrical representation of average and individual probe exhaust gas temperature.
c. Duct nozzle position indication.
d. Reverser position indication.
e. Aerodynamic brake indication.
f. Ignition "On" indication.
g. Low rotor speed indication (electrical counter type).

25.1 Provisions - Provisions for the following instrumentation shall be as shown on the Installation Drawing:

a. High rotor speed tachometer.
b. Oil-in temperature.
c. Oil pressure.
d. Pressure drop across oil strainer.
e. Oil level.
f. Chip detectors (oil).
g. Primary gas generator fuel flowmeter.
h. Duct heater fuel flowmeter.
i. Fuel inlet temperature.
j. Fuel pump inlet pressure.
k. Pressure drop across fuel filter.
l. Vibration pickup mounting brackets (2).

25.2 Special Instrumentation Installation - Installation of all special engine instrumentation must be coordinated with and approved by P&WA.

26.0 TURBINE COOLING SYSTEM - The engine incorporates a self-contained and self-regulating turbine cooling system.

26.1 Turbine Temperature Measurement System - The engine shall be equipped with thermocouples for use in conjunction with the airframe temperature indicating system. The thermocouples shall permit consistent measurement of exhaust gas temperature. The system design shall be such that it is possible to service check individual temperature probes for continuity.

27.0 CUSTOMER REQUIREMENTS

27.1 Drive Power Extractions - The maximum allowable continuous horsepower extractions and overload horsepower extractions at the power takeoff pads for all operating conditions as a function of high pressure compressor rotor speed are as specified in the form of torques and speed ratios on the Installation Drawing.

27.1.1 Dynamic Loading - The dynamic loading limits of the drive pads are specified on the Installation Drawing.

27.1.2 Speeds of Power Takeoff Shafts - Speed ratios of power takeoff shafts are specified on the Installation Drawing.

27.1.3 Shear Section - The shear section requirements are specified on the Installation Drawing.

27.1.4 Loads on Mounting Pads and Power Takeoff (PTO) Shafts - The limiting loads on the mounting pads and PTO shafts are specified on the Installation Drawing.

27.1.5 Environmental Control System (ECS) Compressor Oil Cooling - Fuel may be provided by the engine gas generator fuel pump interstage for airframe ECS compressor oil cooling. This fuel shall be returned to the fuel system upstream of the engine inlet fuel temperature measurement provision. The following limitations shall apply:

a. ECS cooling fuel flow shall not exceed 1500 pph over a 35 to 160 psi pressure drop range.
b. ECS cooling fuel temperature shall not exceed 350°F (176.7°C) in any part of the cooling system.
c. Engine fuel inlet limits shall not be affected by these provisions.

27.2 Compressor Bleed Air

27.2.1 Quality - The engine shall be so designed that it will not contribute to the contamination of air discharging into the cabin air system. Provided that the air entering the engine is free of contamination, the air at the discharge ports shall contain not more than the following amounts of the listed contaminants:

Substances	Parts per Million (Volume)
a. Aldehydes	1.0
b. Carbon Monoxide	50.0
c. Carbon Dioxide	5000.0
d. Ozone	0.1
e. Oxides of Nitrogen	5.0
f. Hydrogen Peroxide	1.0

The air shall not contain a total of more than 5 milligrams per cubic meter of submicron particles. Dirt or other foreign particle concentration in the bleed air after expansion to atmospheric pressure shall not exceed that of the air at the engine inlet on a per unit volume basis. If a demonstration is required P&WA will demonstrate on a normally functioning engine on a P&WA plant test stand that the above requirements are met within the accuracy of the testing technique available to P&WA at the time of the demonstration. However, it must be recognized that there may be occasional instances in service operation when the bleed air is contaminated.

27.2.1.1 Seals and Oil Lines - Accessory seals, bearing seals, and oil lines shall be designed so that a single failure (except for engine bearing failure) can not result in bleed air contamination. P&WA shall submit a failure analysis to the airframe manufacturer to demonstrate how the design meets this requirement.

27.2.2 Quantity - The engine shall provide for high pressure compressor air extraction, for aircraft use, as indicated:

a. Within the operating envelope of the engine, high compressor air will be available in quantities not to exceed 5% of gas generator airflow from idle to a thrust corresponding to a turbine exhaust gas temperature 80°F (44.4°C) less than that corresponding to maximum cruise.

c. All accessory drive and vibration or friction dampener springs.
d. Starter jaw.
e. All gears.
f. All quill and accessory drive shafts.

30.1.2 Fluorescent Penetrant Inspection - The following parts, if made of nonmagnetic materials, shall be subject to fluorescent penetrant inspection in accordance with P&WA established procedures:

a. All parts of the compressor-turbine rotor assembly, including threaded fastenings except those parts on which anodic inspection is used.
b. Turbine nozzle vanes and assemblies.
c. All other highly stressed parts.

Very bulky and intricately shaped parts may be hydrostatically tested by the P&WA approved method in lieu of fluorescent testing. Radiographic inspection may be substituted for fluorescent penetrant inspection of fusion welds.

30.1.3 Excepted Parts - Low stressed parts, such as cotter pins, washers, etc., are not required to be inspected by the magnetic or fluorescent methods.

30.1.4 Radiographic or Ultrasonic Inspection - The following shall be subject to radiographic or ultrasonic inspection:

a. The compressor rotors, if nonmagnetic.
b. The turbine rotors, if nonmagnetic.
c. Highly stressed nonmagnetic castings.

30.1.4.1 Radiographic Inspection - Radiographic inspection of materials shall be in accordance with P&WA established procedures. Laboratories performing radiographic inspection shall be certified in accordance with P&WA requirements.

30.1.5 Certification of Operators - All fusion welding shall be performed by operators who are certified in accordance with P&WA established procedures.

31.0 PREPARATION FOR DELIVERY

31.1 Preparation for Storage and Shipment - The engine, components, and accessories shall be prepared for storage and shipment in accordance with P&WA established procedures. P&WA shall furnish a packing list with each engine. All parts, accessories, components, and tools which are not installed on the engine, but which are shipped with the engine, shall be included on the packing list. P&WA shall furnish with each engine the Acceptance Run Log with all performance data.

Figure 3

JTF17A-21L TURBOFAN ENGINE
MANEUVER LOAD DIAGRAM

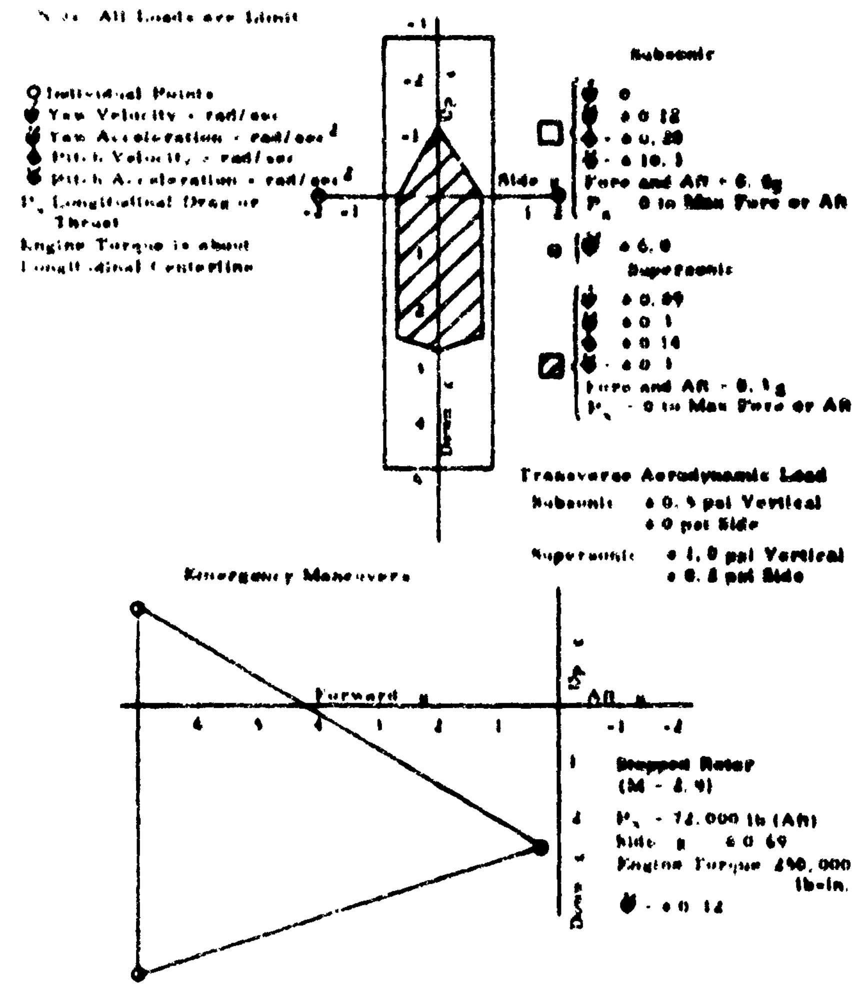
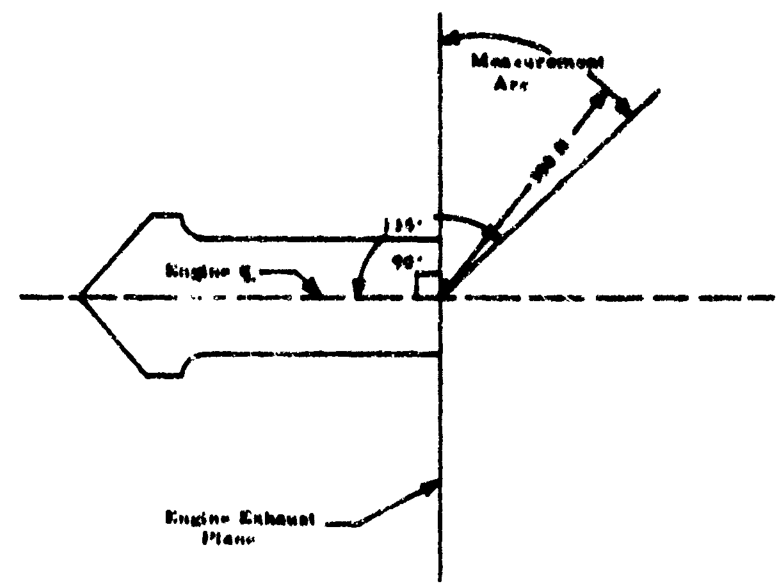


Figure 4

JTF17A-21L TURBOFAN ENGINE
NOISE LEVEL MEASUREMENT DIAGRAM



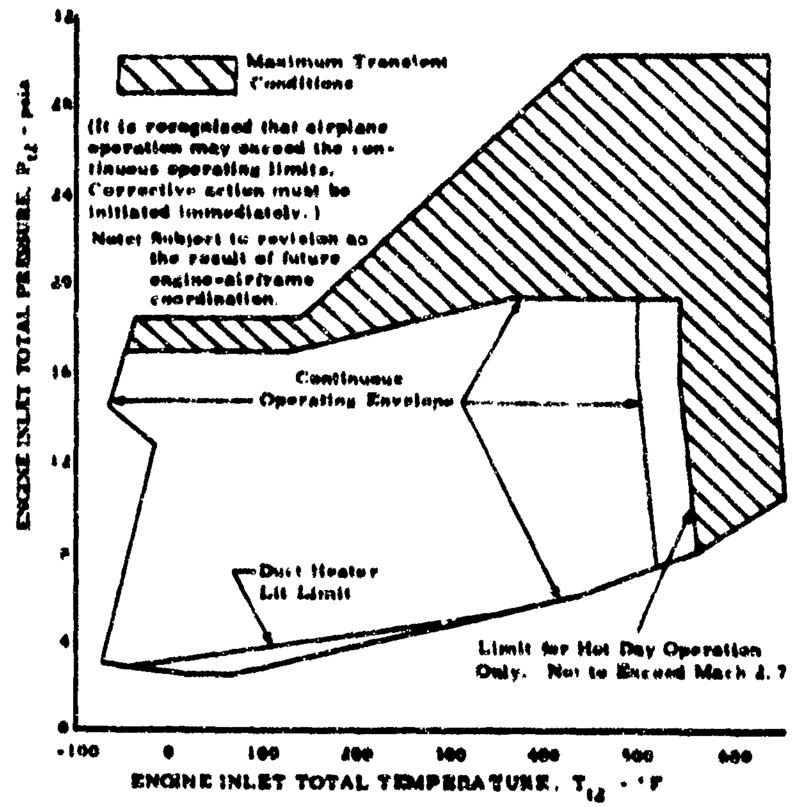
Estimated JTF17A-21L Turbofan Engine Performance

PWA Deck No. 5572 Date: 8-8-66

Sheet 1

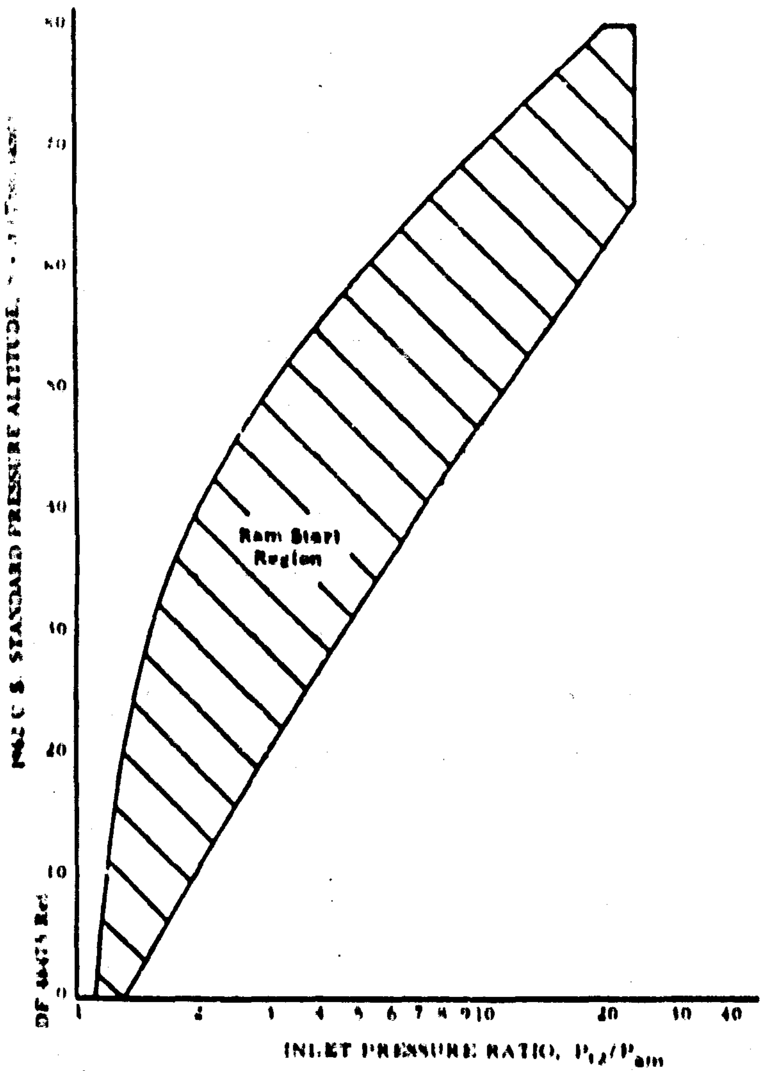
Curve No. 8-82

JTF17A-21L TURBOFAN ENGINE
ESTIMATED ENGINE OPERATING ENVELOPE

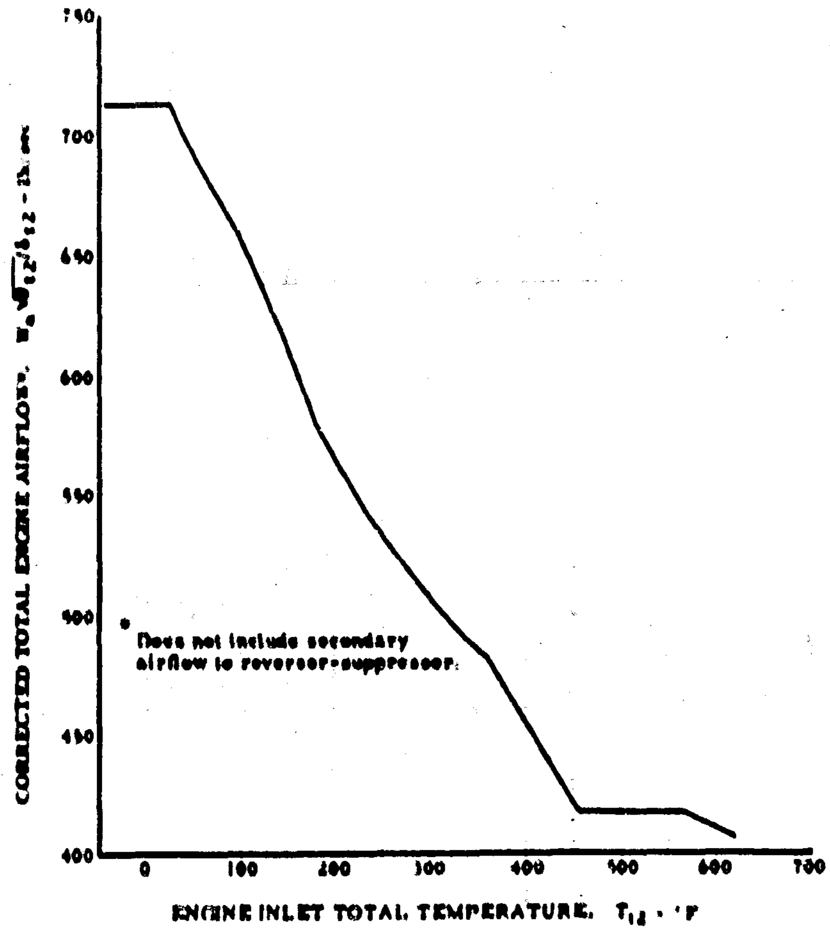


Sheet 2

JTF17A-21L TURBOFAN ENGINE
ESTIMATED WINDMILLING RESTART ENVELOPE
NO AERODYNAMIC BRAKING



JTF17A-21L TURBOFAN ENGINE
ESTIMATED CORRECTED AIRFLOW SCHEDULE
AT
MAXIMUM NONAUGMENTED THROUGH MAXIMUM AUGMENTED POWER

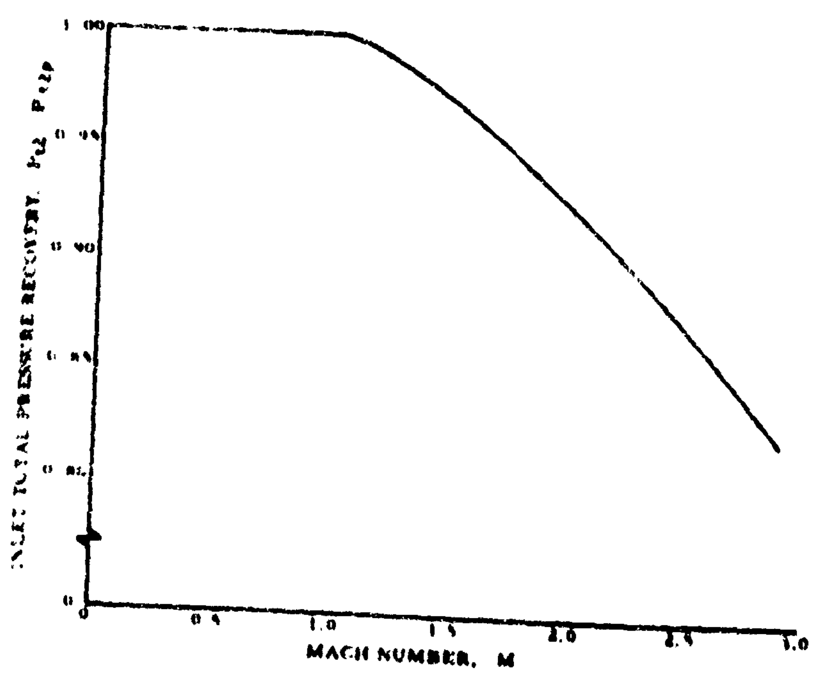


Curve No. [illegible]

JTF17A-21L TURBOFAN ENGINE
ESTIMATED INLET TOTAL PRESSURE RECOVERY P_{t2}/P_{t2p}
PER (MIL-E-5008B)

Below Mach 1 - 1.0
Above Mach 1 - 1.0 - 0.075 (M-1.0)^1.35

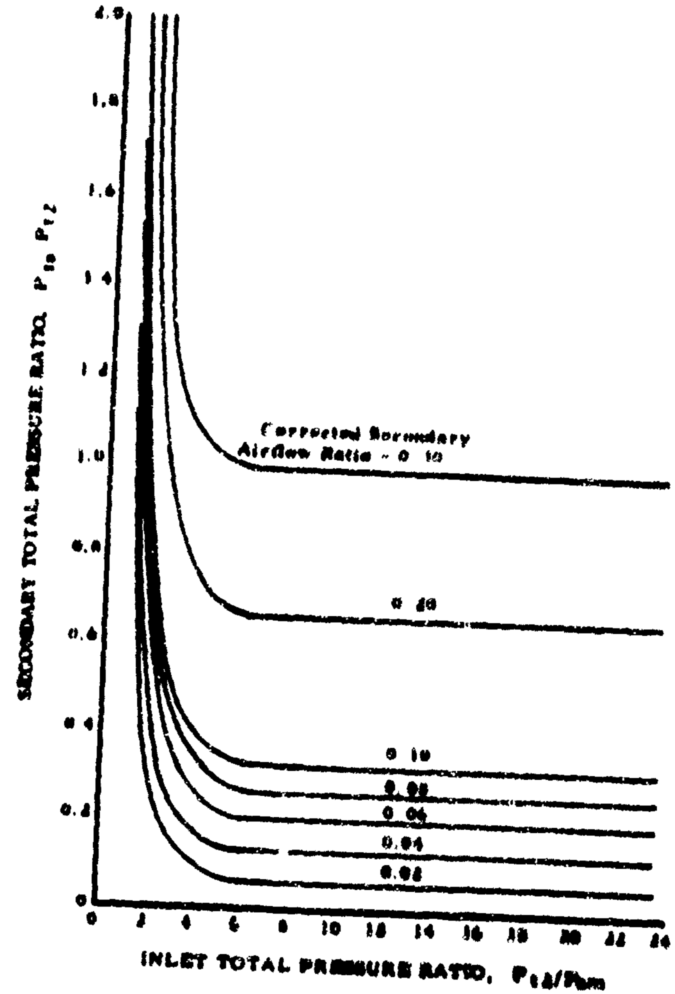
P_{t2} = Compressor Inlet Total Pressure
P_{t2p} = Isentropic Compressor Inlet Total Pressure



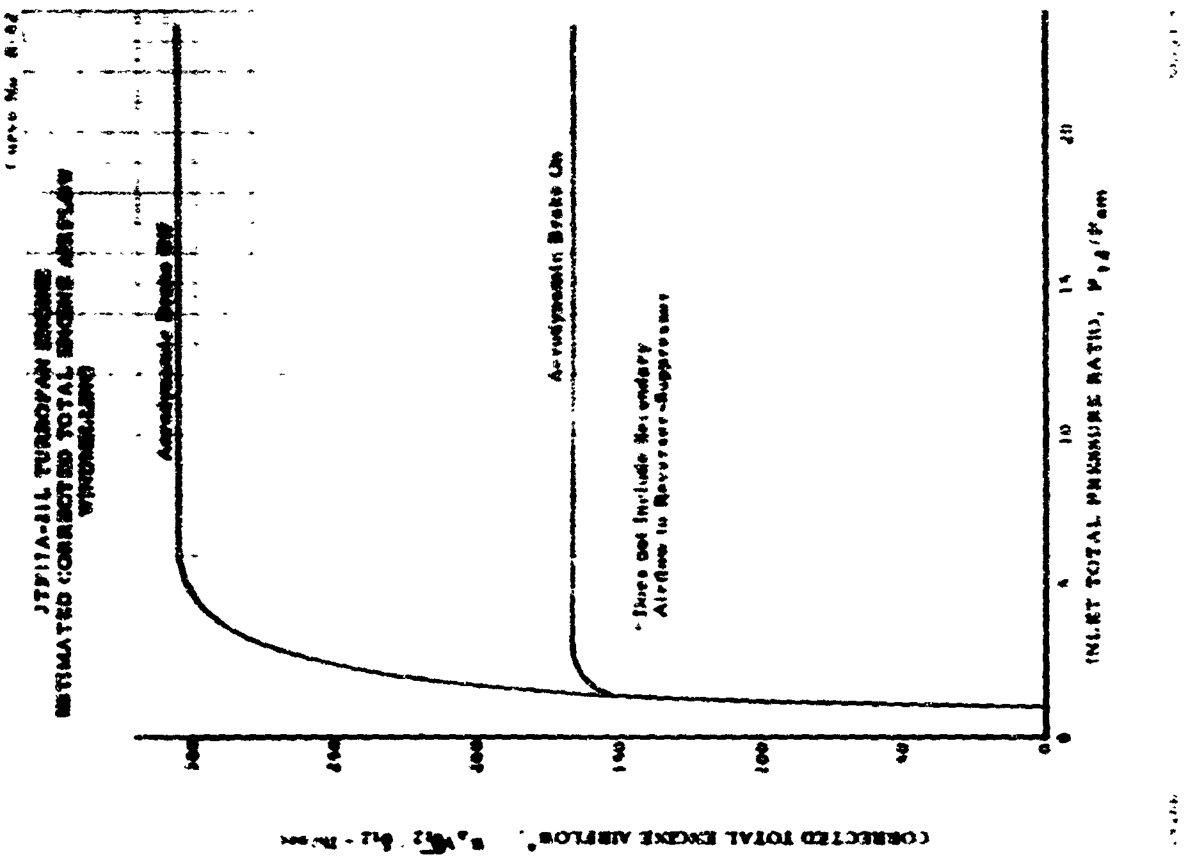
Sheet 5

Curve No. [illegible]

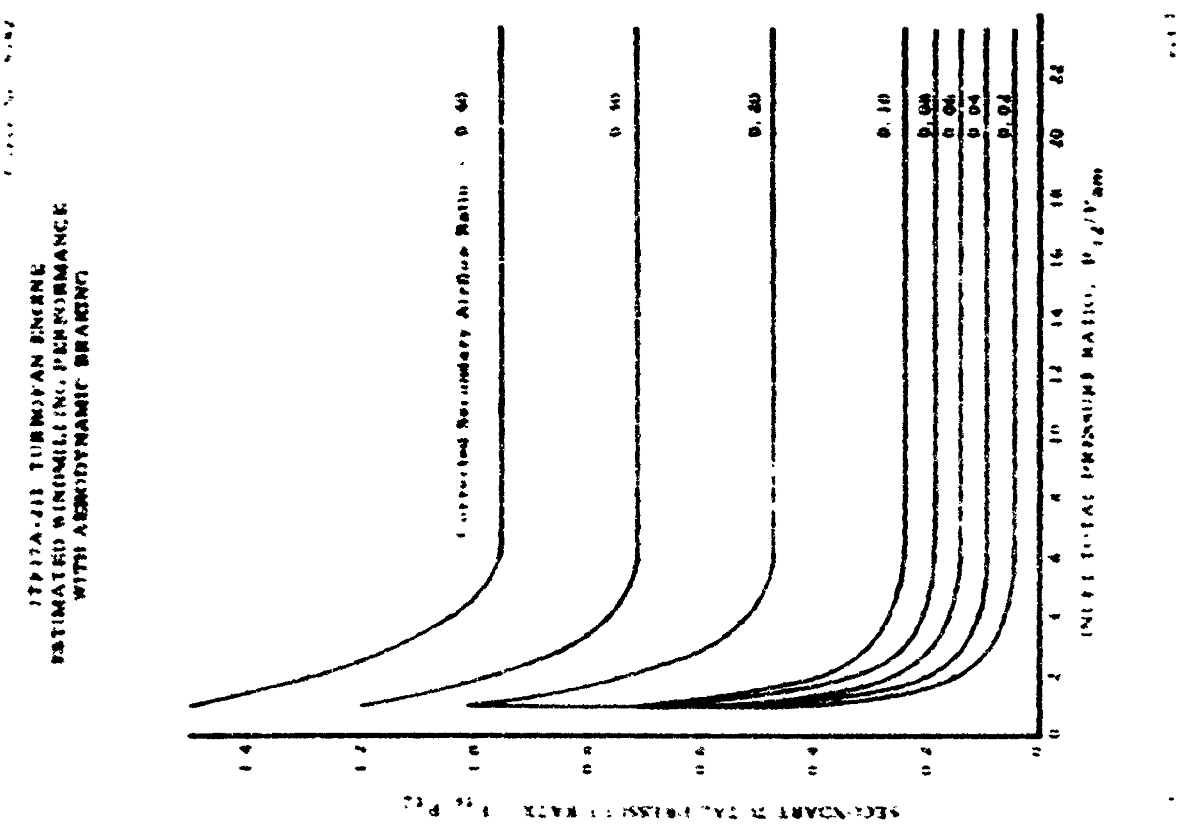
JTF17A-21L TURBOFAN ENGINE
ESTIMATED WINDMILLING PERFORMANCE
WITHOUT AERODYNAMIC BRAKING



Sheet 6



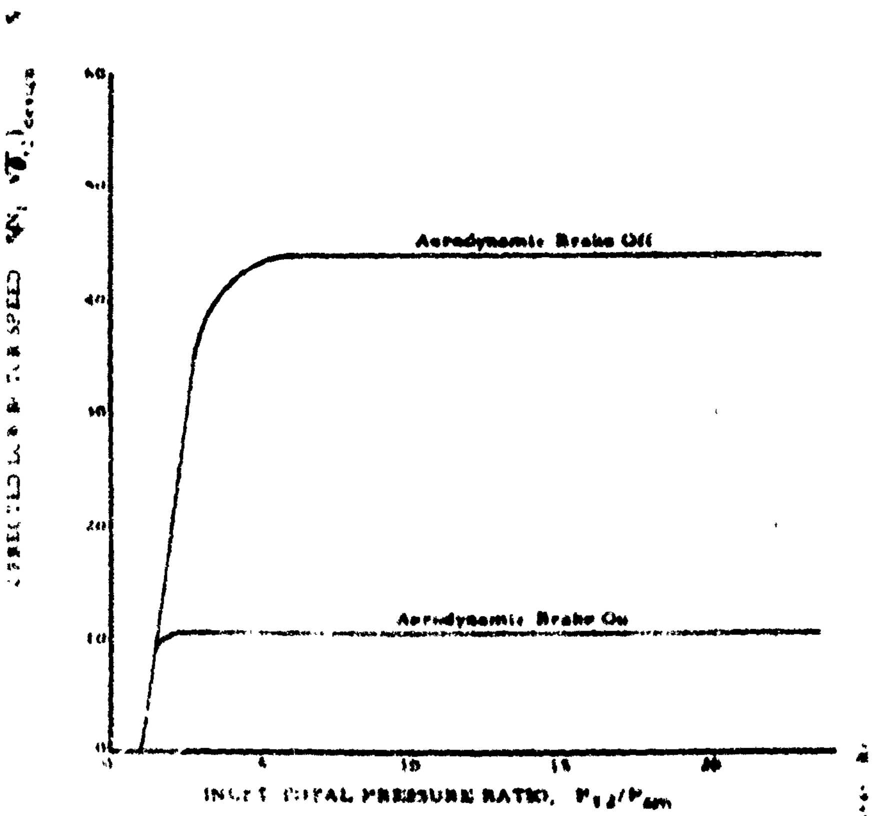
JTF17A-21L TURBOFAN ENGINE
ESTIMATED CORRECTED TOTAL ENGINE AIRFLOW
WINDMILLING
Aerodynamic Brake Off
Aerodynamic Brake On
* Does not Include Secondary Airflow to Reverser-Suppressor
INLET TOTAL PRESSURE RATIO, P_{t2}/P_{am}
CORRECTED TOTAL ENGINE AIRFLOW*
0
5
10
15
20



JTF17A-21L TURBOFAN ENGINE
ESTIMATED WINDMILLING PERFORMANCE
WITH AERODYNAMIC BRAKING
Corrected Secondary Airflow Ratio = 0.40
0.30
0.20
0.10
0.08
0.06
0.04
0.02
INLET TOTAL PRESSURE RATIO, P_{t2}/P_{am}
0
2
4
6
8
10
12
14
16
18
20
22

JTFITA-41L TURBOFAN ENGINE
ESTIMATED CORRECTED LOW ROTOR SPEED
WINDMILLING

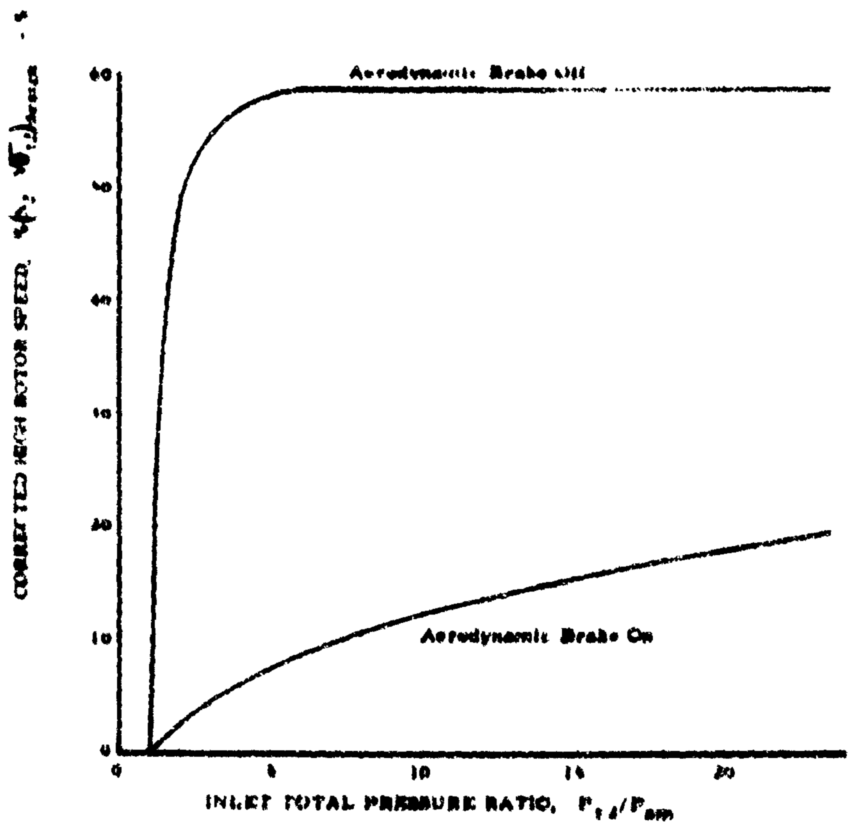
NOTE
Design corrected low rotor speed
$N_1/\sqrt{\theta_{t2}}$ - 6490 rpm



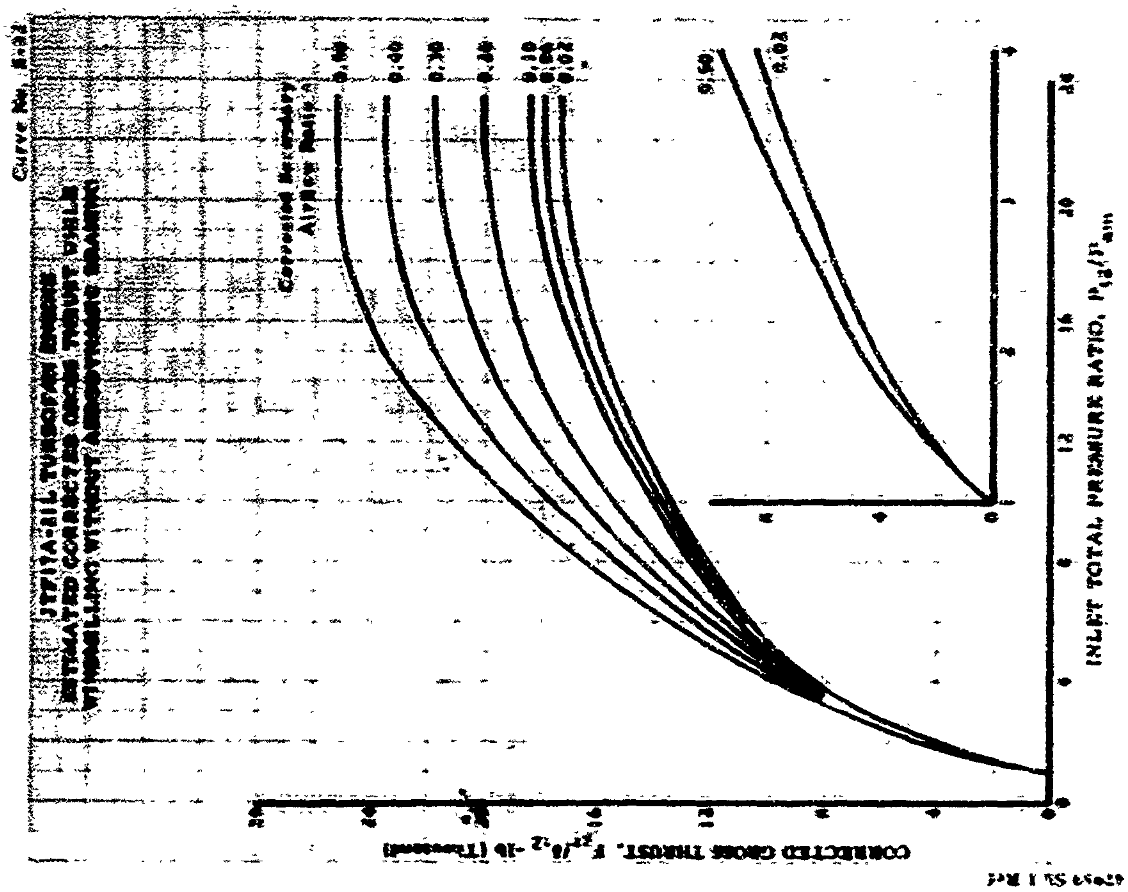
Sheet 9

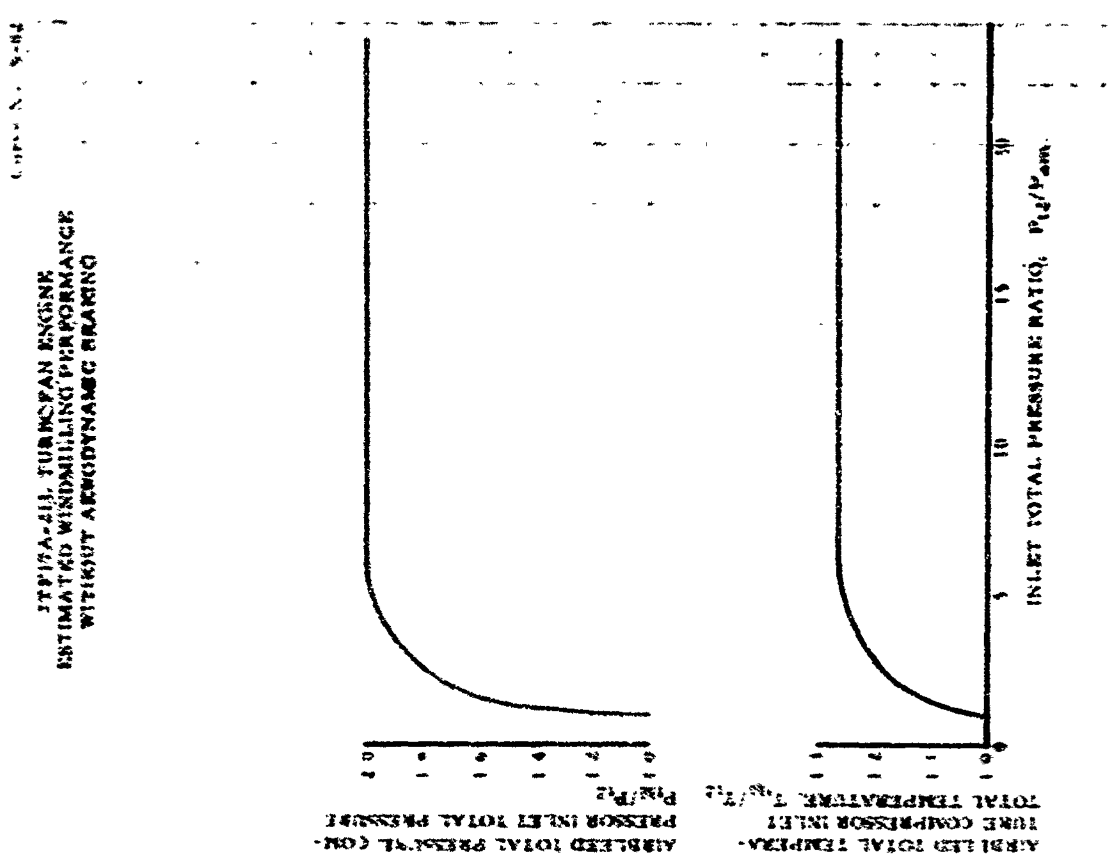
JTFITA-41L TURBOFAN ENGINE
ESTIMATED CORRECTED HIGH ROTOR SPEED
WINDMILLING

NOTE
Design corrected high rotor speed
$N_2/\sqrt{\theta_{t2}}$ 4190 rpm

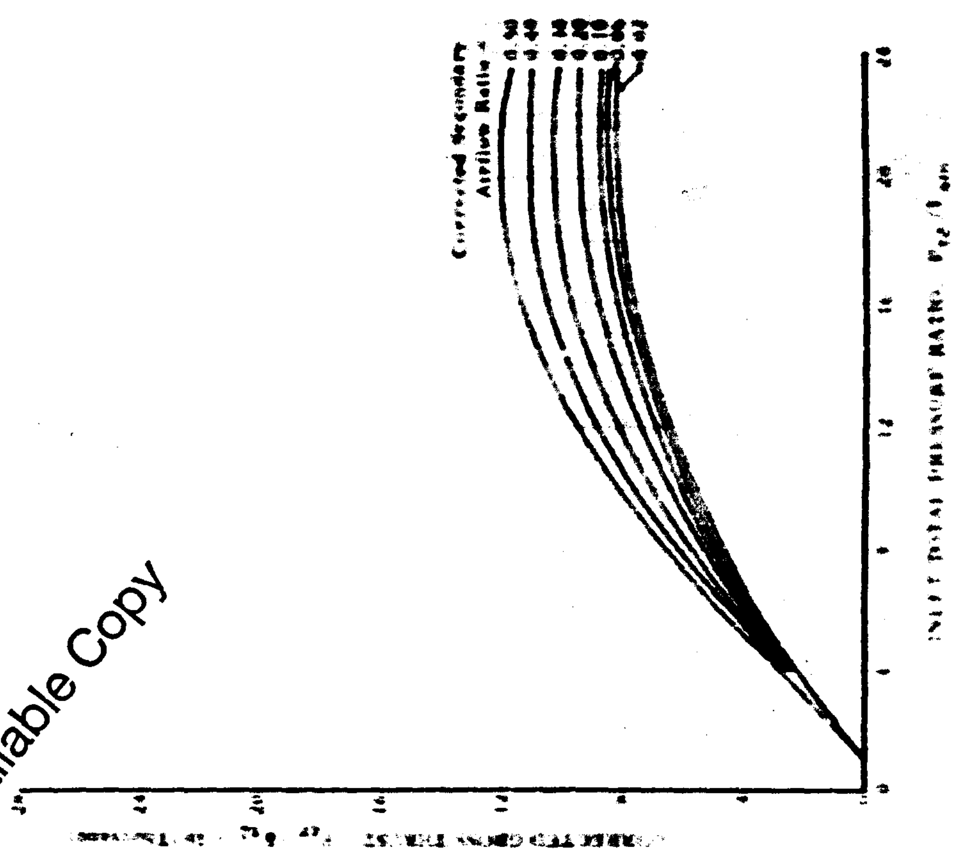


Sheet 10

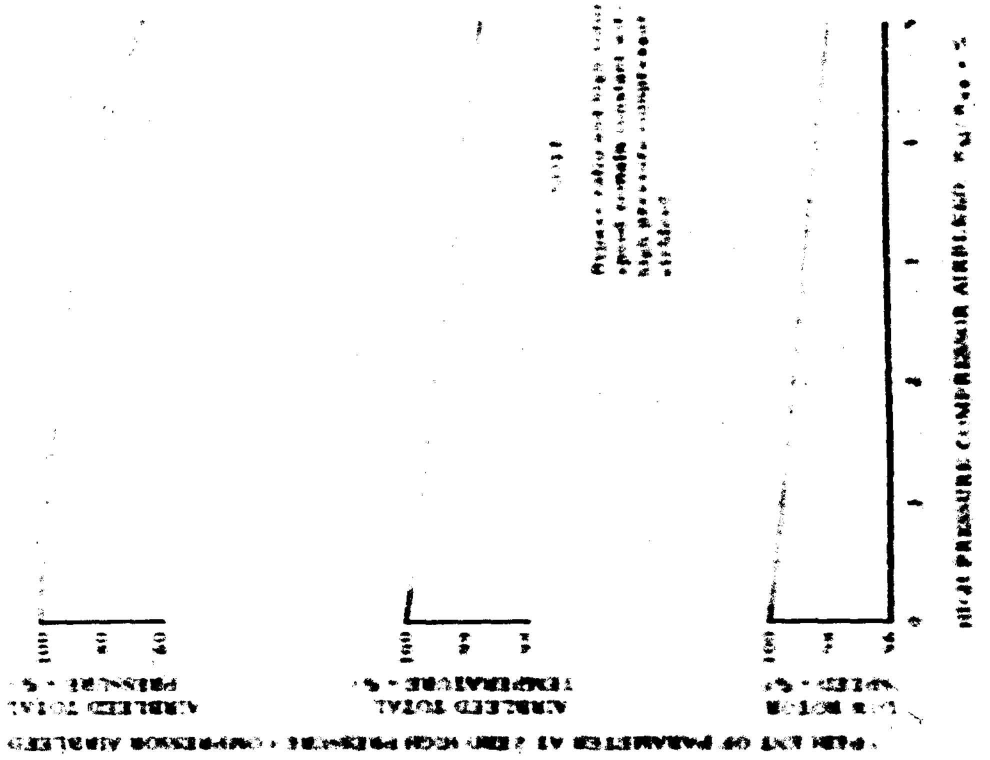




[illegible] TURBOFAN ENGINE
ESTIMATED CORRECTED GROSS THRUST WHILE
WINDMILLING WITH AERODYNAMIC BRAKING

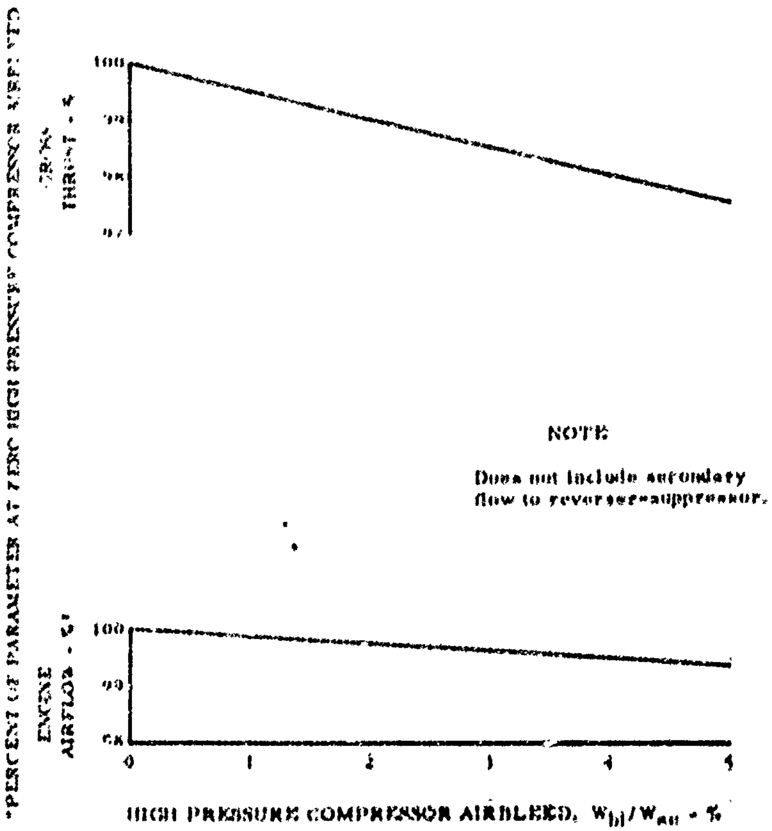


[illegible] TURBOFAN ENGINE
ESTIMATED VARIATION OF WINDMILLING
PERFORMANCE WITH HIGH PRESSURE
COMPRESSOR AIRBLEED



Curve No. S-82

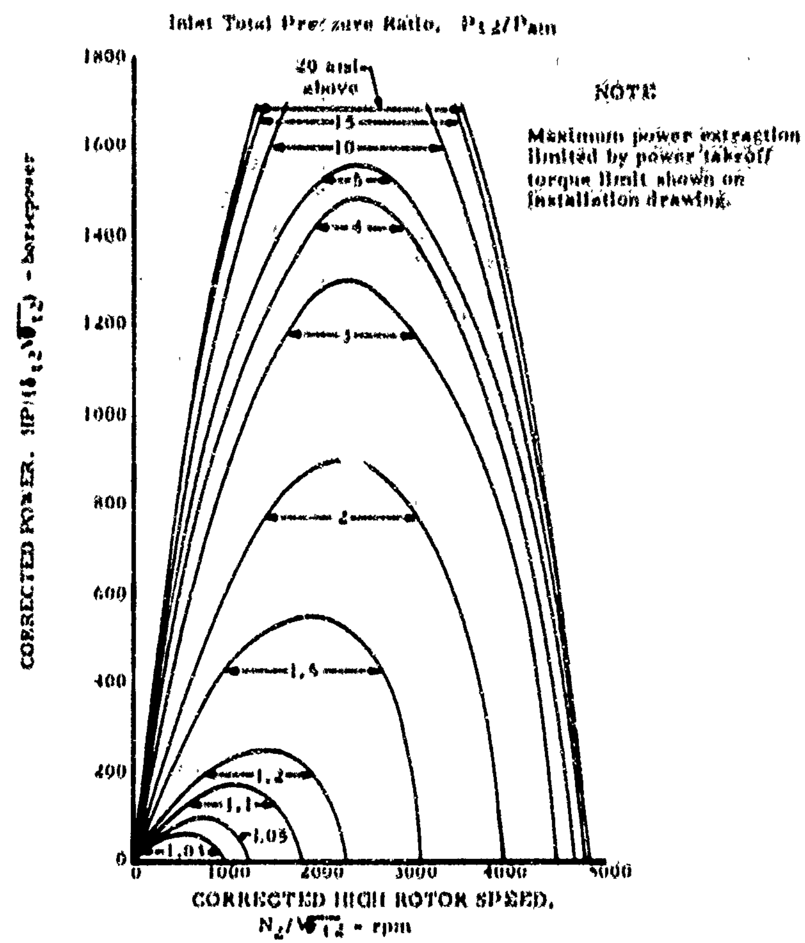
**JT9TA-21L TURBOFAN ENGINE
ESTIMATED VARIATION OF WINDMILLING
PERFORMANCE WITH HIGH PRESSURE
COMPRESSOR AIRBLEED**



Sheet 15

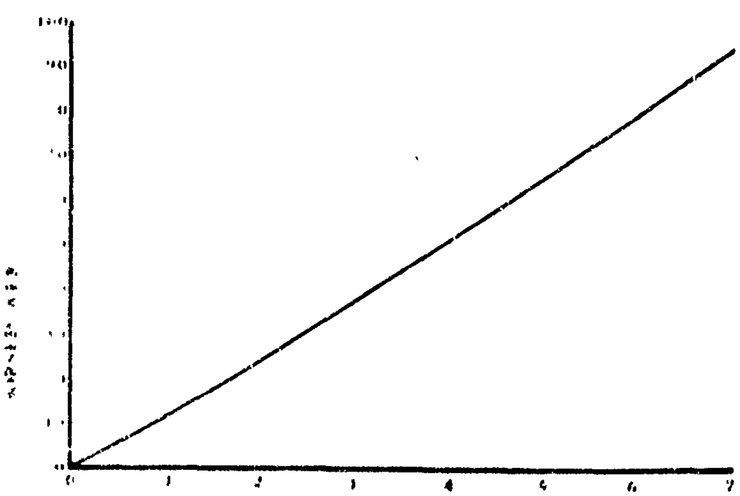
Curve No. S-83

**JT9TA-21L TURBOFAN ENGINE
ESTIMATED POWER AVAILABLE FROM
HIGH PRESSURE ROTOR WITH ENGINE
WINDMILLING AND NO AERODYNAMIC BRAKING**



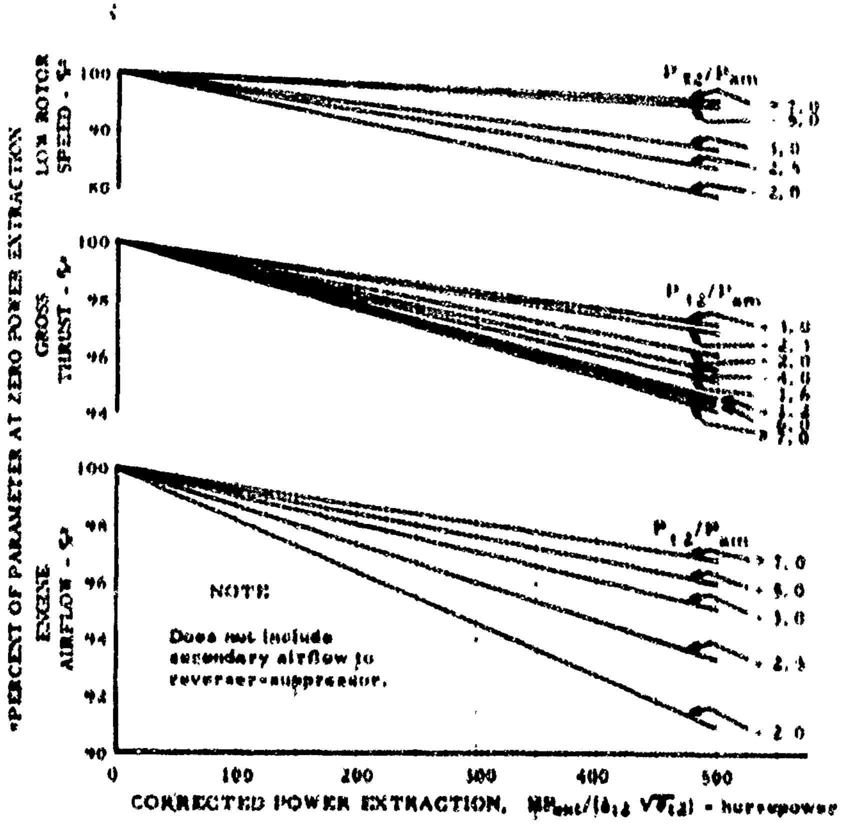
Sheet 16

JTF17A-21L TURBOFAN ENGINE
ESTIMATED POWER REQUIRED TO OVERCOME ENGINE ACCESSORY LOADS AND HIGH ROTOR FRICTION WHILE WINDMILLING



Sheet 17

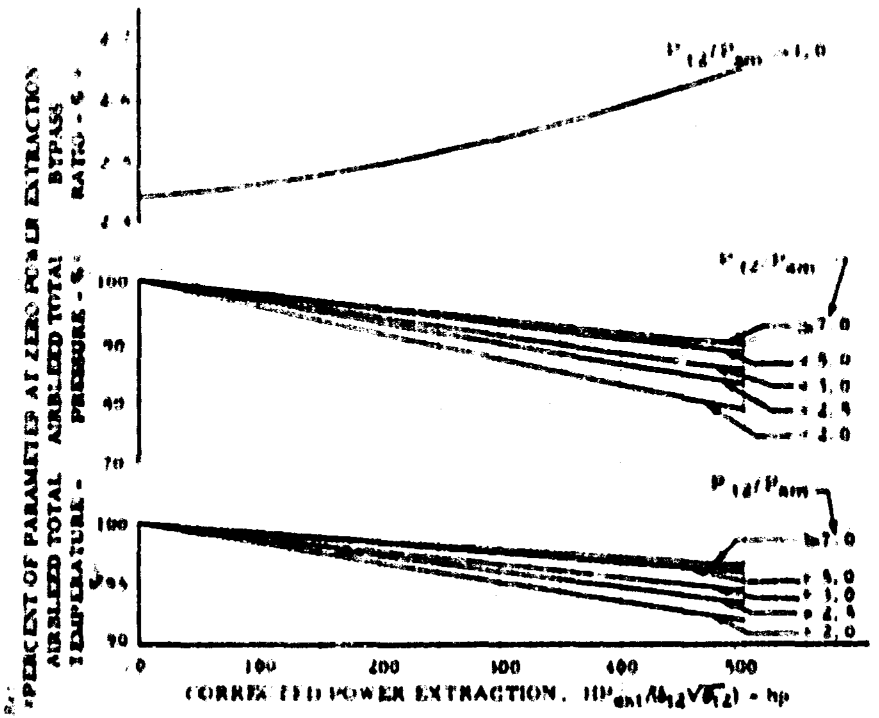
JTF17A-21L TURBOFAN ENGINE
ESTIMATED VARIATION OF WINDMILLING PERFORMANCE WITH POWER EXTRACTIONS



Sheet 18

JTF17A-21L TURBOFAN ENGINE
ESTIMATED VARIATION OF WINDMILLING
PERFORMANCE WITH POWER EXTRACTION

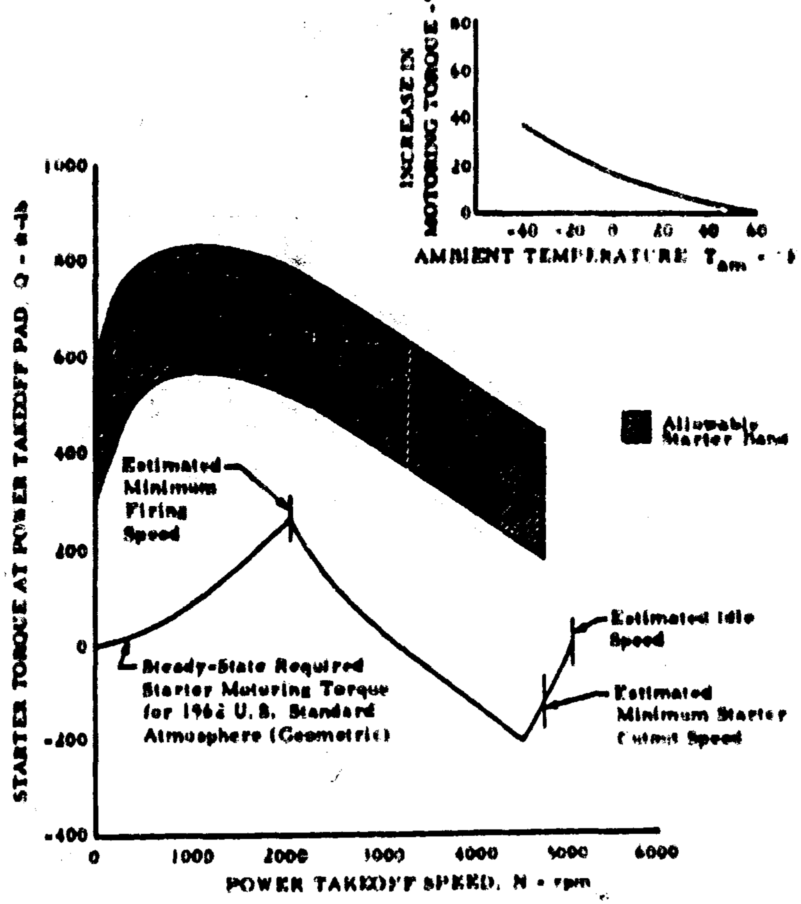
Best Available Copy



JTF17A-21L TURBOFAN ENGINE
ESTIMATED STARTING REQUIREMENTS
ZERO POWER EXTRACTION
INLET PRESSURE RECOVERY PER SHEET 4
SEA LEVEL STATIC

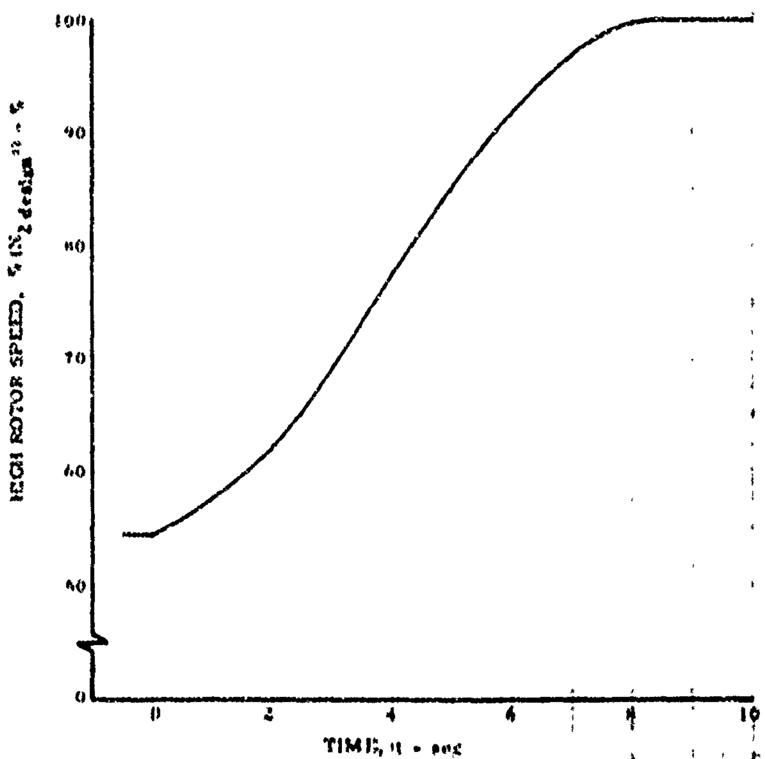
NOTE

(1) Gear ratio = 1.129
(PTO speed = 1.129 N_2, engine speed)
(2) Equivalent mass polar moment of inertia at PTO pad = 16.9 slug ft²



Curve No. 8-82

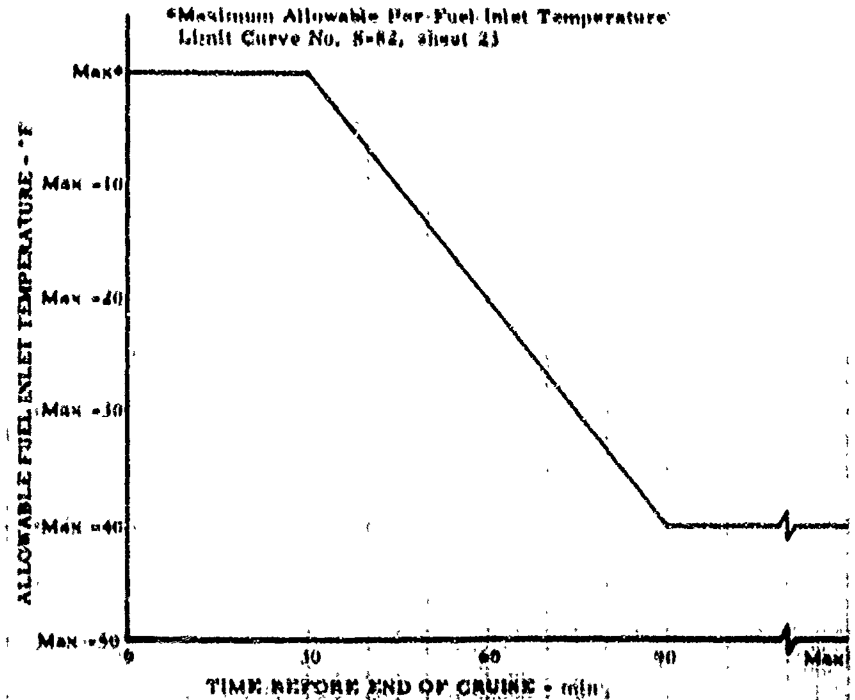
JTF17A-21L TURBOFAN ENGINE
ESTIMATED ENGINE ACCELERATION TIME FROM IDLE TO MAXIMUM THRUST
1962 U.S. STANDARD ATMOSPHERE (GEOMETRIC)
INLET PRESSURE RECOVERY PER SHEET 5
SEA LEVEL STATIC



8-8-66 Sheet 21

Curve No. 8-84

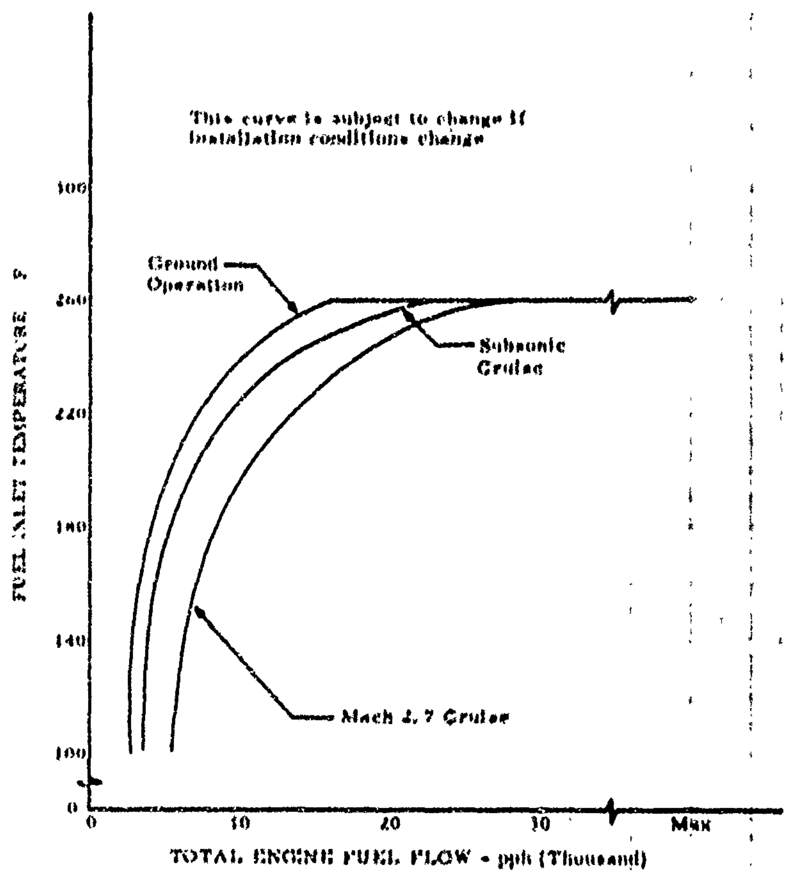
JTF17A-21L TURBOFAN ENGINE
ALLOWABLE TIME AT MAXIMUM FUEL TEMPERATURE LIMIT



8-8-66 Sheet 22

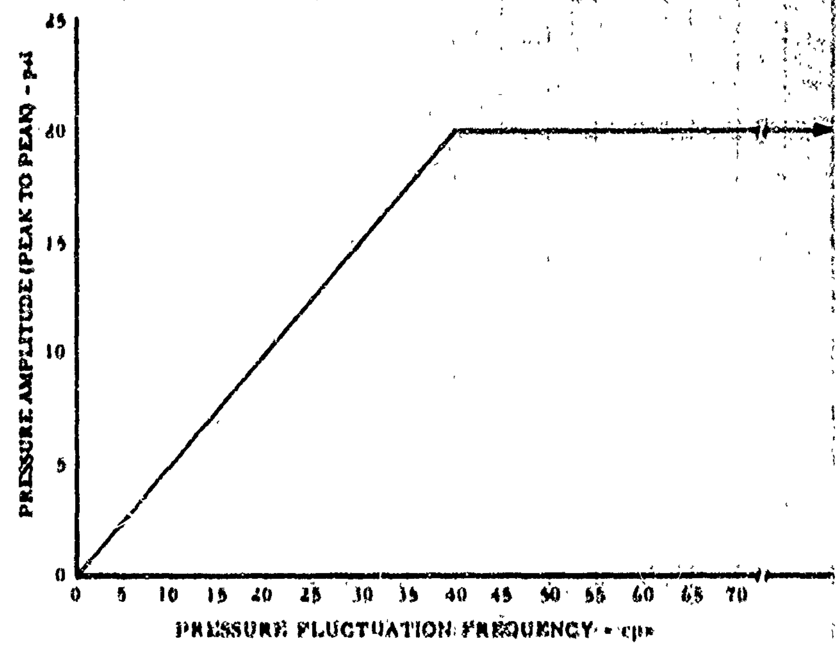
Curve No. 8-83

JTF17A-21L TURBOFAN ENGINE
FUEL INLET TEMPERATURE LIMITS
ALLOWABLE UP TO 10 MINUTES BEFORE END OF CRUISE
REFER TO SHEET 22 FOR LIMITS OVER 10 MINUTES
PWA 522 (JET A, A-1)
NO HEAT RETURN TO AIRFRAME



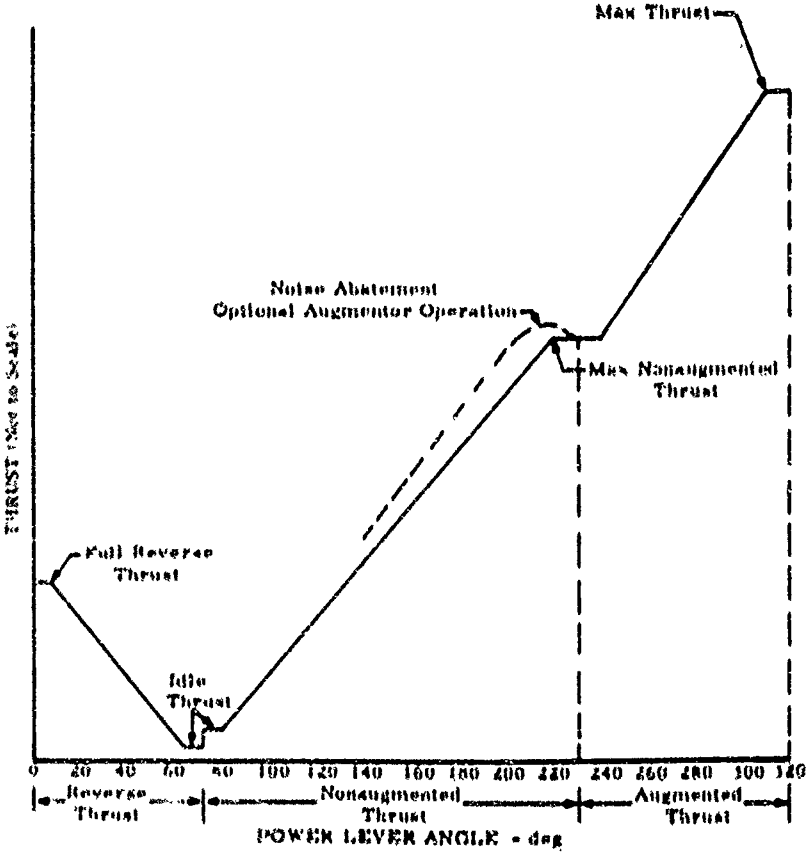
Curve No. 8-82

JTF17A-21L TURBOFAN ENGINE
ESTIMATED ALLOWABLE FUEL PRESSURE FLUCTUATION
AT ENGINE FUEL INLET CONNECTION



Curve No. 8-82

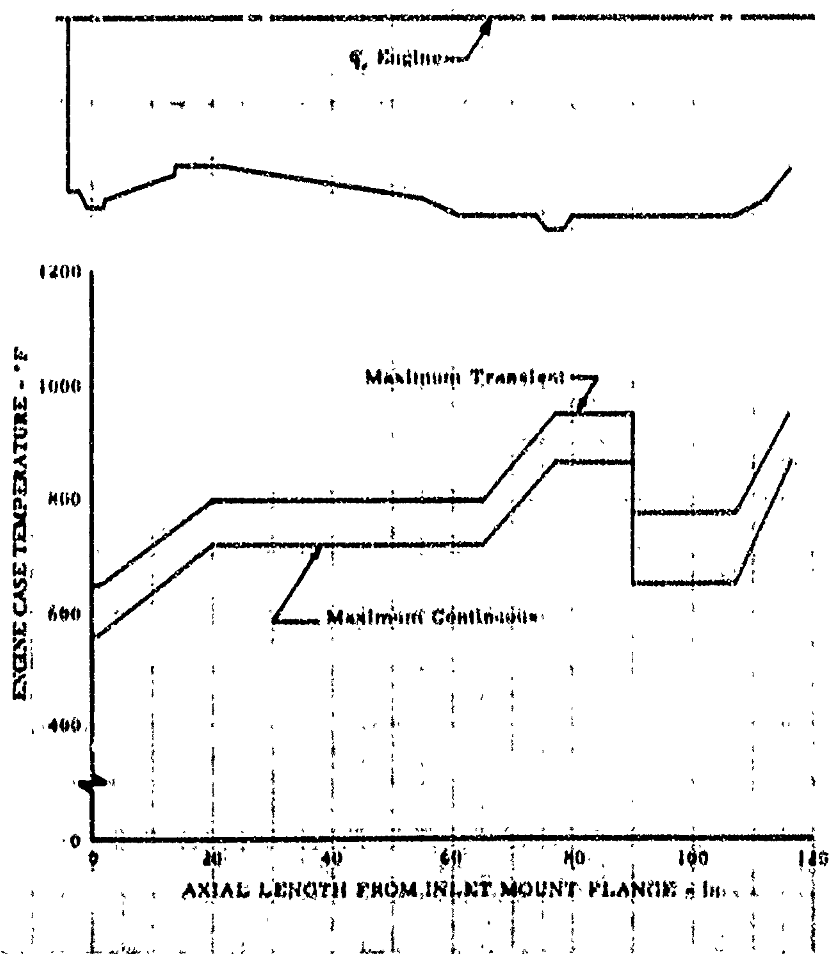
JTF17A-21L TURBOFAN ENGINE
ESTIMATED POWER LEVER OPERATION
(FUNCTIONAL REPRESENTATION)



Sheet 25

Curve No. 8-84

JTF17A-21L TURBOFAN ENGINE
MAXIMUM ALLOWABLE ESTIMATED CASE
TEMPERATURES VS ENGINE LENGTH



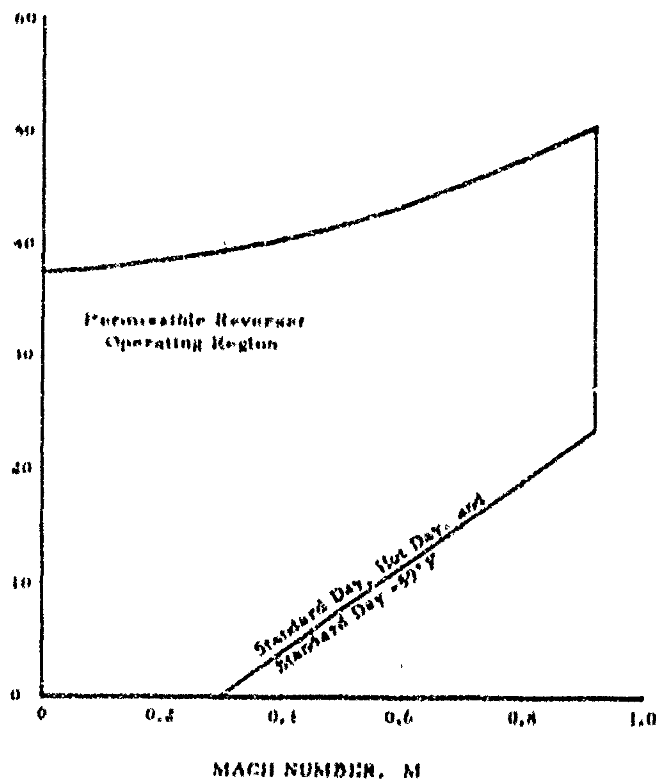
8-8-66

Sheet 26

Curve No. 8-82

JTF17A-21L TURBOFAN ENGINE
ESTIMATED ENVELOPE FOR MAXIMUM REVERSE
INLET PRESSURE RECOVERY PER SHEET 5

NOTE
Hot day definition
a) 0 to 6000 ft altitude
T_{am} = T_{am} Std Day + 27° F
b) Above 6000 ft altitude
T_{am} = T_{am} Std Day + 18° F

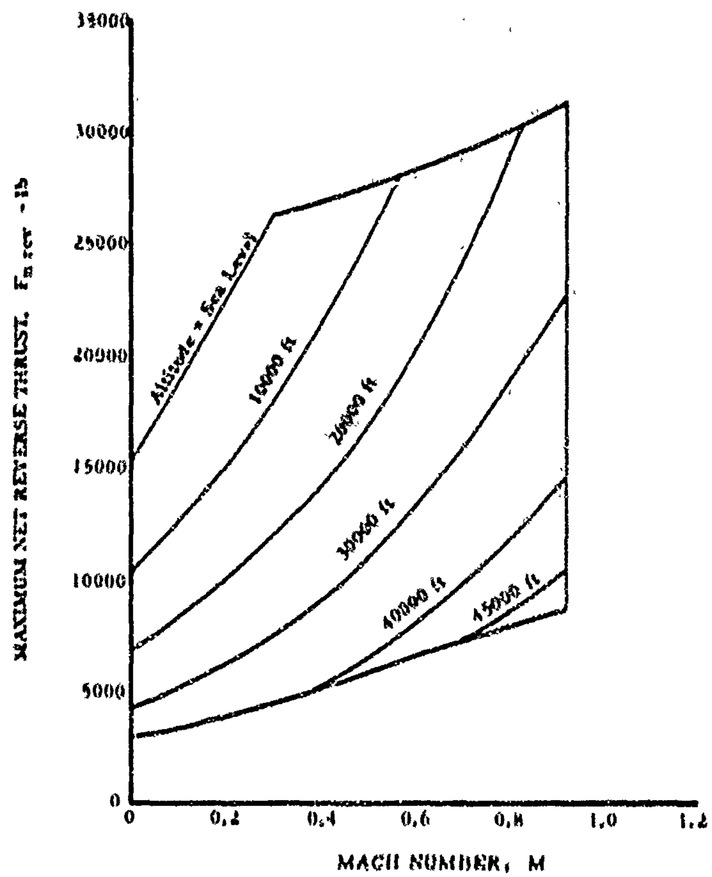


Sheet 47

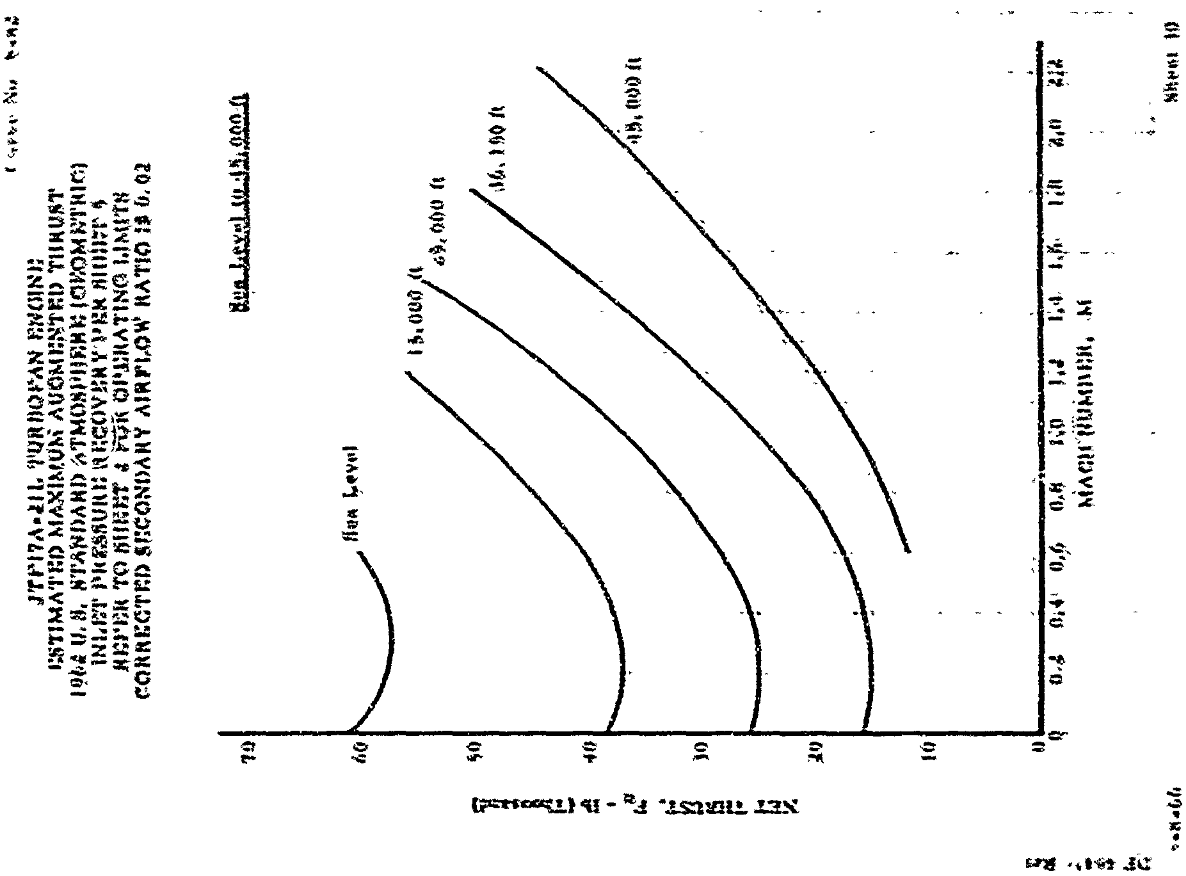
DF 49232 Ref
8-8-66

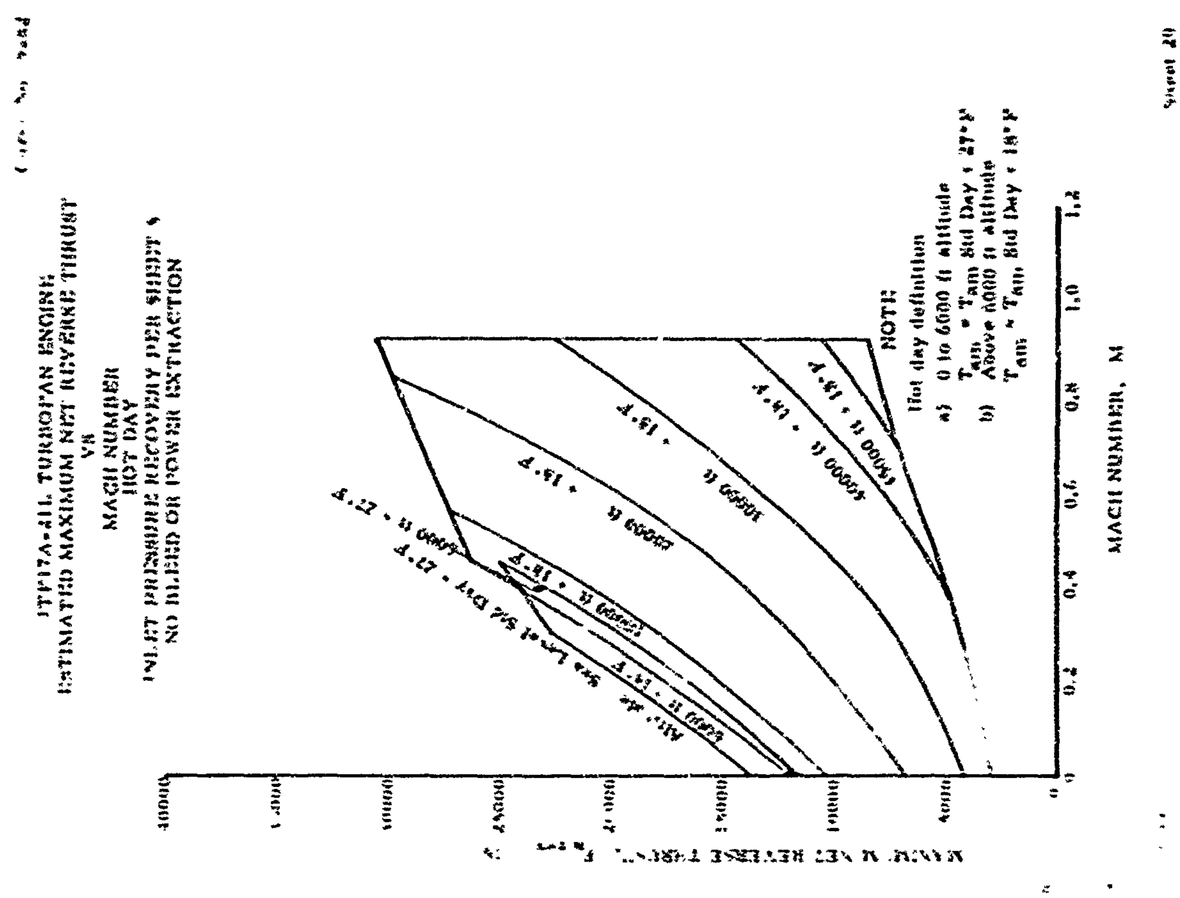
Curve No. 8-82

JTF17A-21L TURBOFAN ENGINE
ESTIMATED MAXIMUM NET REVERSE THRUST
VS
MACH NUMBER
STANDARD DAY TO STANDARD +59° F DAY
INLET PRESSURE RECOVERY PER SHEET 5
NO BLEED OR POWER EXTRACTION



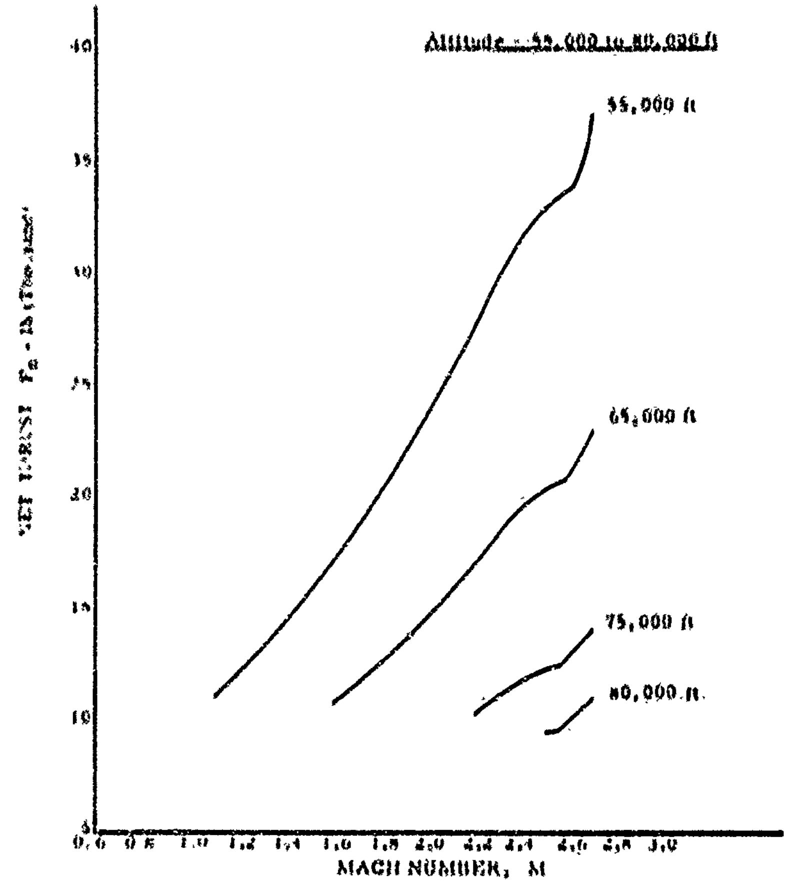
Sheet 48


JTF17A-21L TURBOFAN ENGINE
ESTIMATED MAXIMUM AUGMENTED THRUST
1962 U.S. STANDARD ATMOSPHERE (GEOMETRIC)
INLET PRESSURE RECOVERY PER SHEET 5
REFER TO SHEET 4 FOR OPERATING LIMITS
CORRECTED SECONDARY AIRFLOW RATIO IS 0.02
Sea Level to 45,000 ft
Sea Level
15,000 ft
36,150 ft
45,000 ft
NET THRUST, Fn - lb (Thousand)
MACH NUMBER, M
Sheet 19


JTF17A-21L TURBOFAN ENGINE
ESTIMATED MAXIMUM NET REVERSE THRUST
VS
MACH NUMBER
HOT DAY
INLET PRESSURE RECOVERY PER SHEET 5
NO BLEED OR POWER EXTRACTION
NOTE
Hot day definition
a) 0 to 6000 ft altitude
Tam = Tam Std Day + 27°F
b) Above 6000 ft altitude
Tam = Tam Std Day + 18°F
MACH NUMBER, M
Sheet 20

Curve No. 8-82

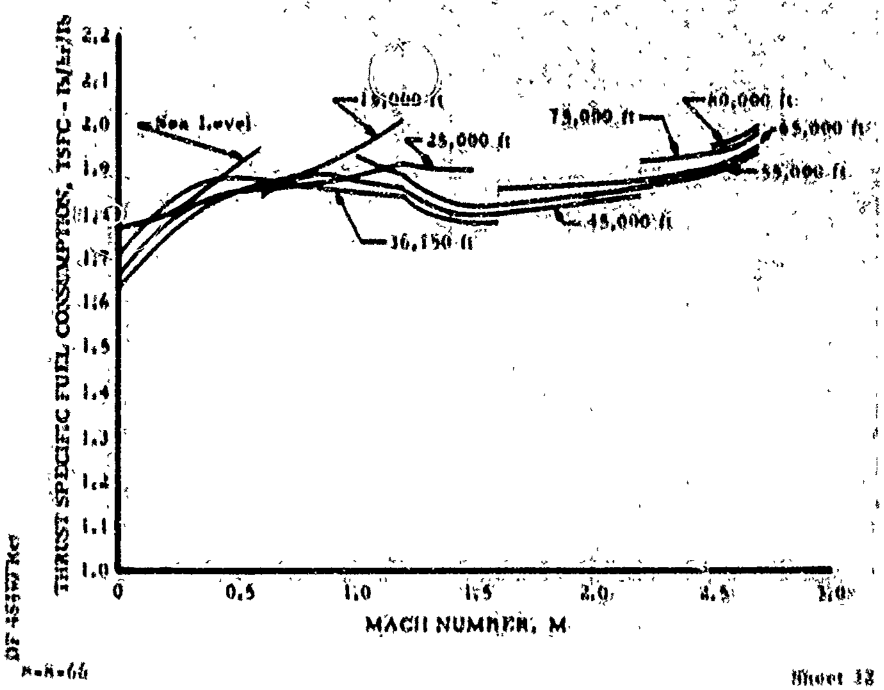
JTF17A-21L TURBOFAN ENGINE
ESTIMATED MAXIMUM AUGMENTED THRUST
1962 U.S. STANDARD ATMOSPHERE (GEOMETRIC)
INLET PRESSURE RECOVERY PER SHEET 5
REFER TO SHEET 2 FOR OPERATING LIMITS
CORRECTED SECONDARY AIRFLOW RATIO IS 0.02



Sheet 31

Curve No. 8-82

JTF17A-21L TURBOFAN ENGINE
ESTIMATED MAXIMUM AUGMENTED TSFC
1962 U.S. STANDARD ATMOSPHERE (GEOMETRIC)
INLET PRESSURE RECOVERY PER SHEET 5
REFER TO SHEET 2 FOR OPERATING LIMITS
CORRECTED SECONDARY AIRFLOW RATIO IS 0.02

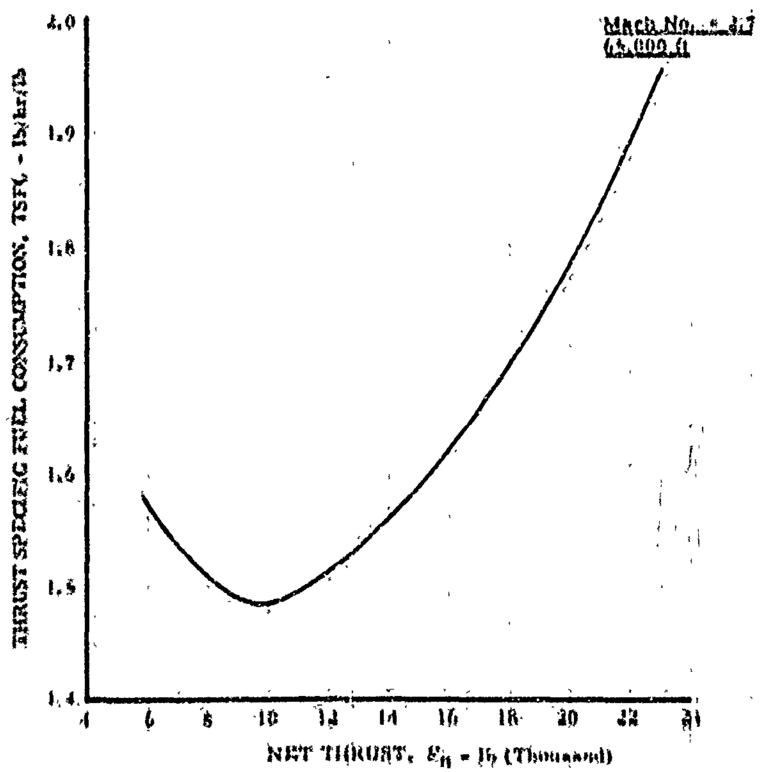


DF 45597 K6
8-8-66

Sheet 32

Curve No. S-82

JTF17A-21L TURBOFAN ENGINE
ESTIMATED PARTIALLY AUGMENTED PERFORMANCE
1962 U.S. STANDARD ATMOSPHERE (GEOMETRIC)
INLET PRESSURE RECOVERY PER SHEET 5
REFER TO SHEET 2 FOR OPERATING LIMITS
CORRECTED SECONDARY AIRFLOW RATIO IS 0.02



DF 46433 Rev
9-8-66

Sheet 44

LOCATION			ACCESSORY DRIVE PADS
SHEET 1	SHEET 2	SHEET 3	
[illegible]	[illegible]	[illegible]	[illegible]

FUEL DRAINS [illegible]

[illegible]

FUEL VENT

[illegible]

FUEL PRESSURE

[illegible]

FUEL TEMPERATURE

[illegible]

OIL BREATHER

[illegible]

OIL DRAINS

[illegible]

OIL PRESSURE

[illegible]

OIL TEMPERATURE

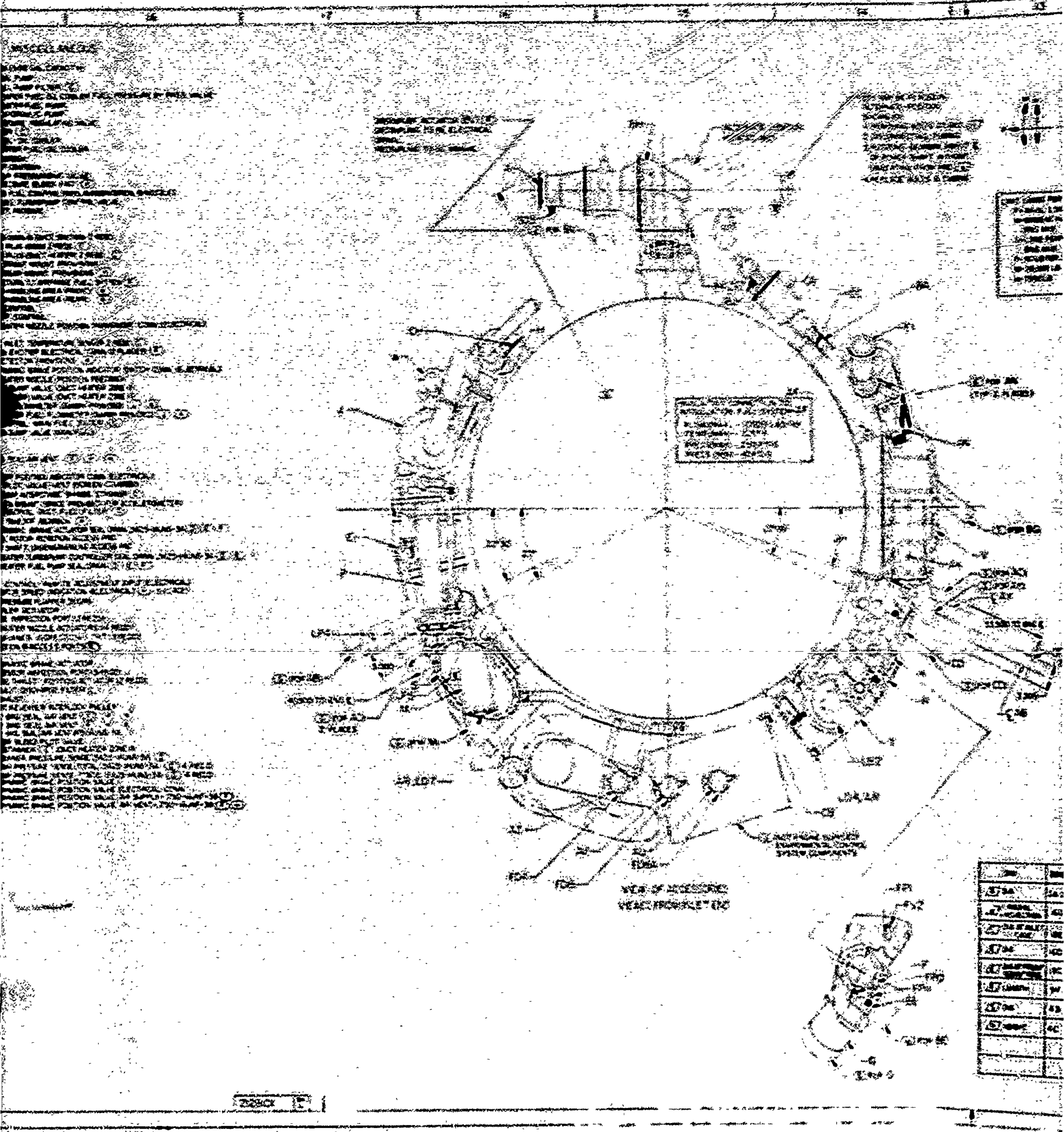
[illegible]

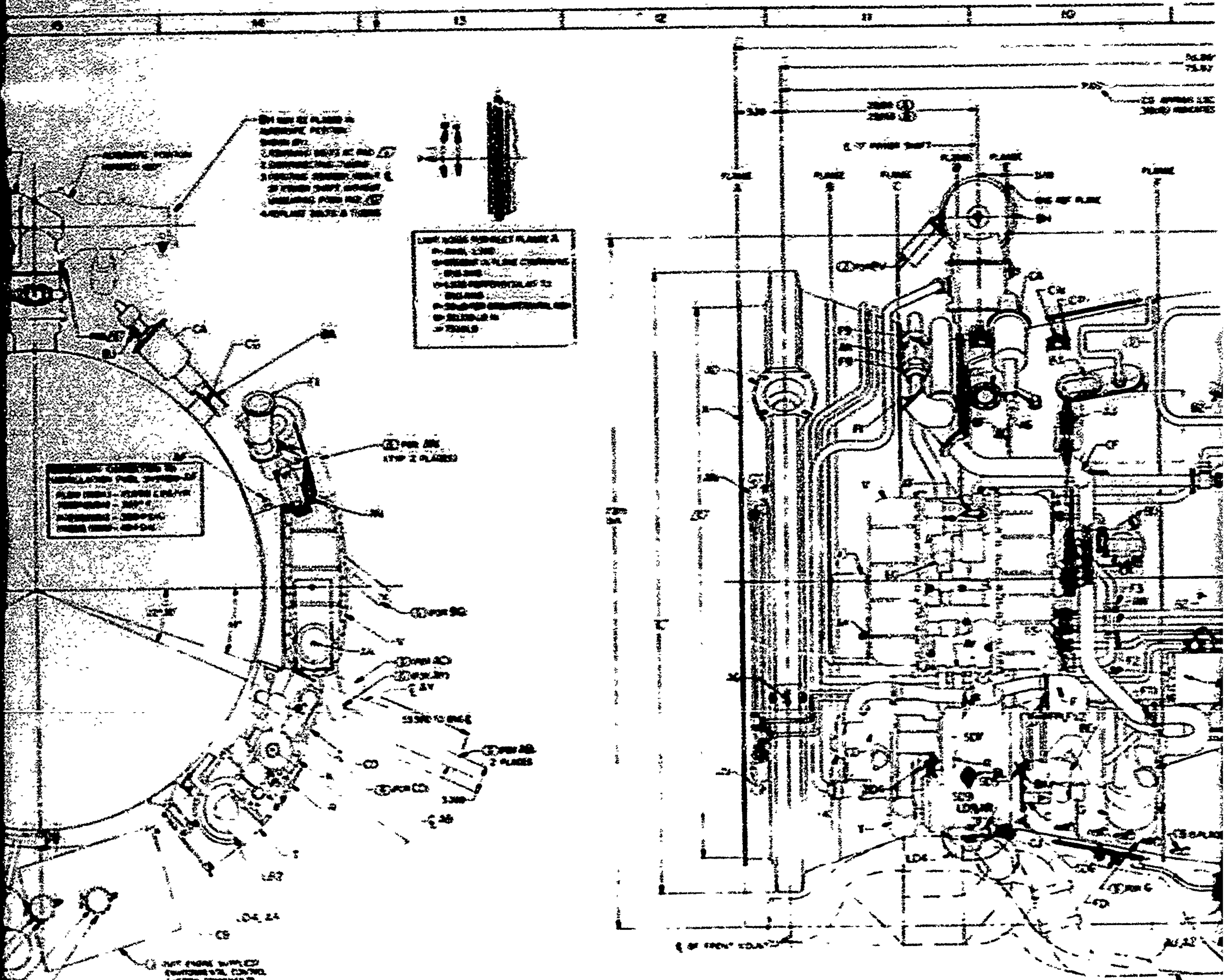
OIL VENT

[illegible]

LOCATION				MISCELLANEOUS
SHEET 1	SHEET 2	SHEET 3	SHEET 4	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

4





16
15
13
12
11
10
OF ACCESSORIES
ED FROM INLET END

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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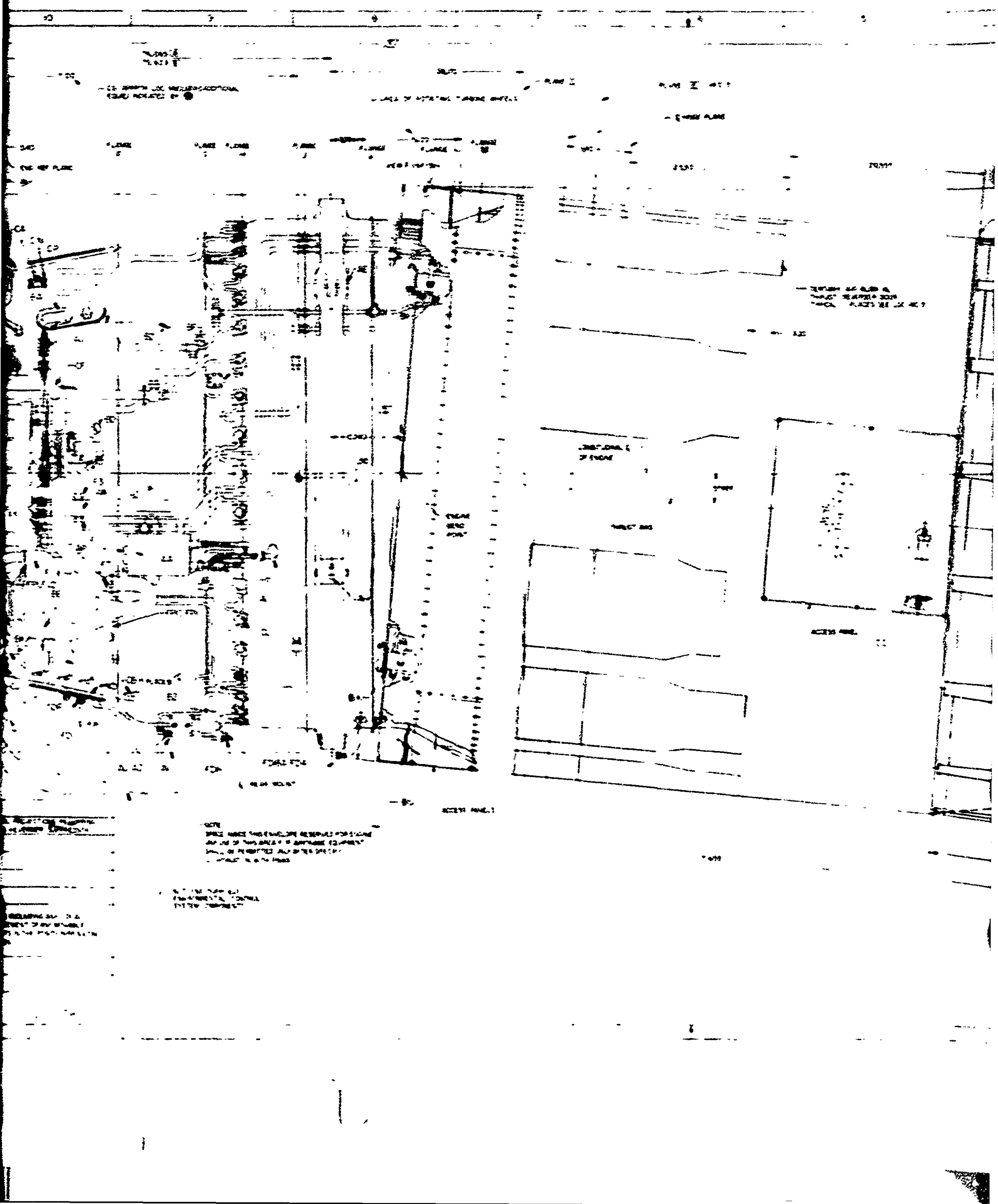
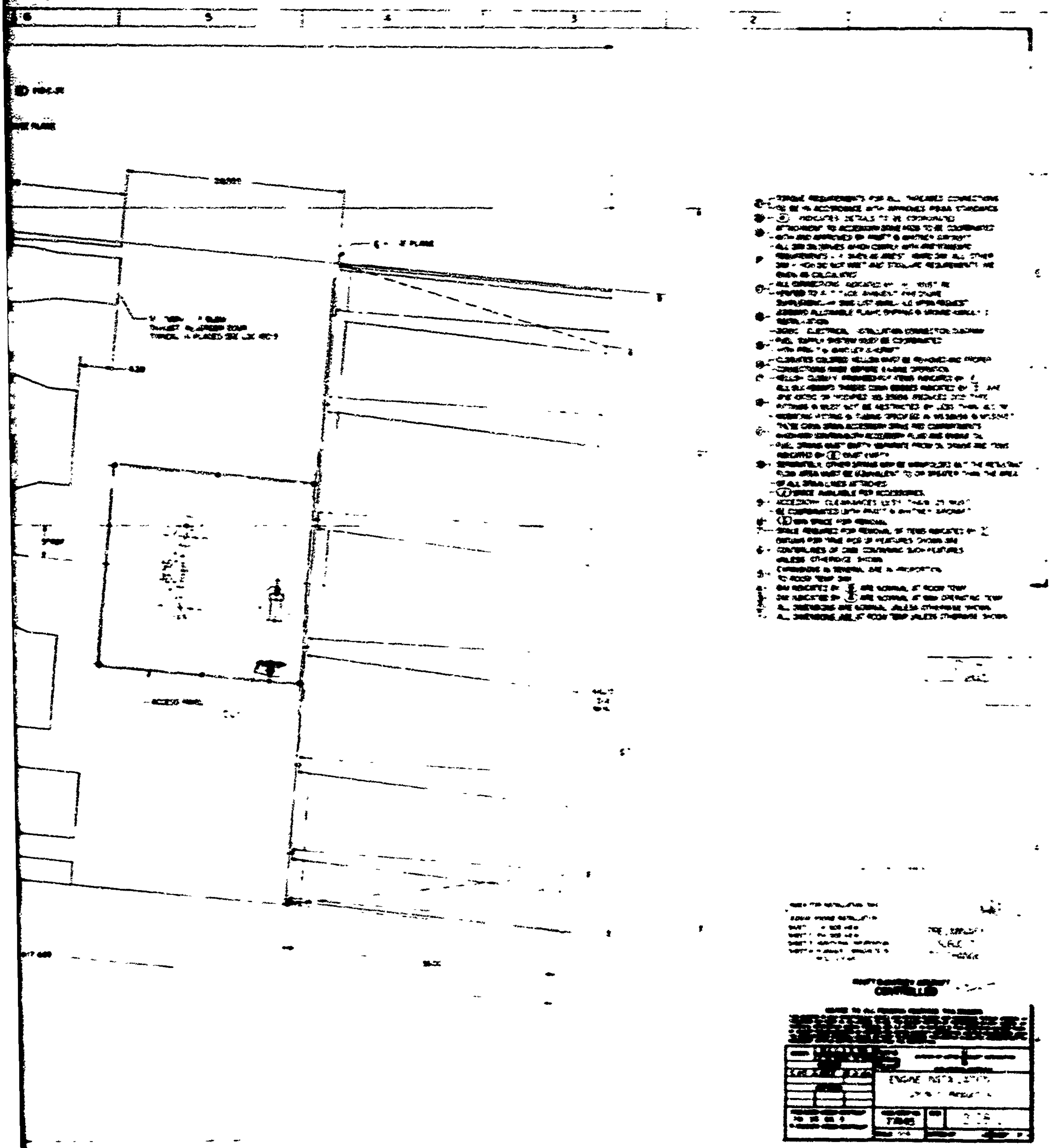
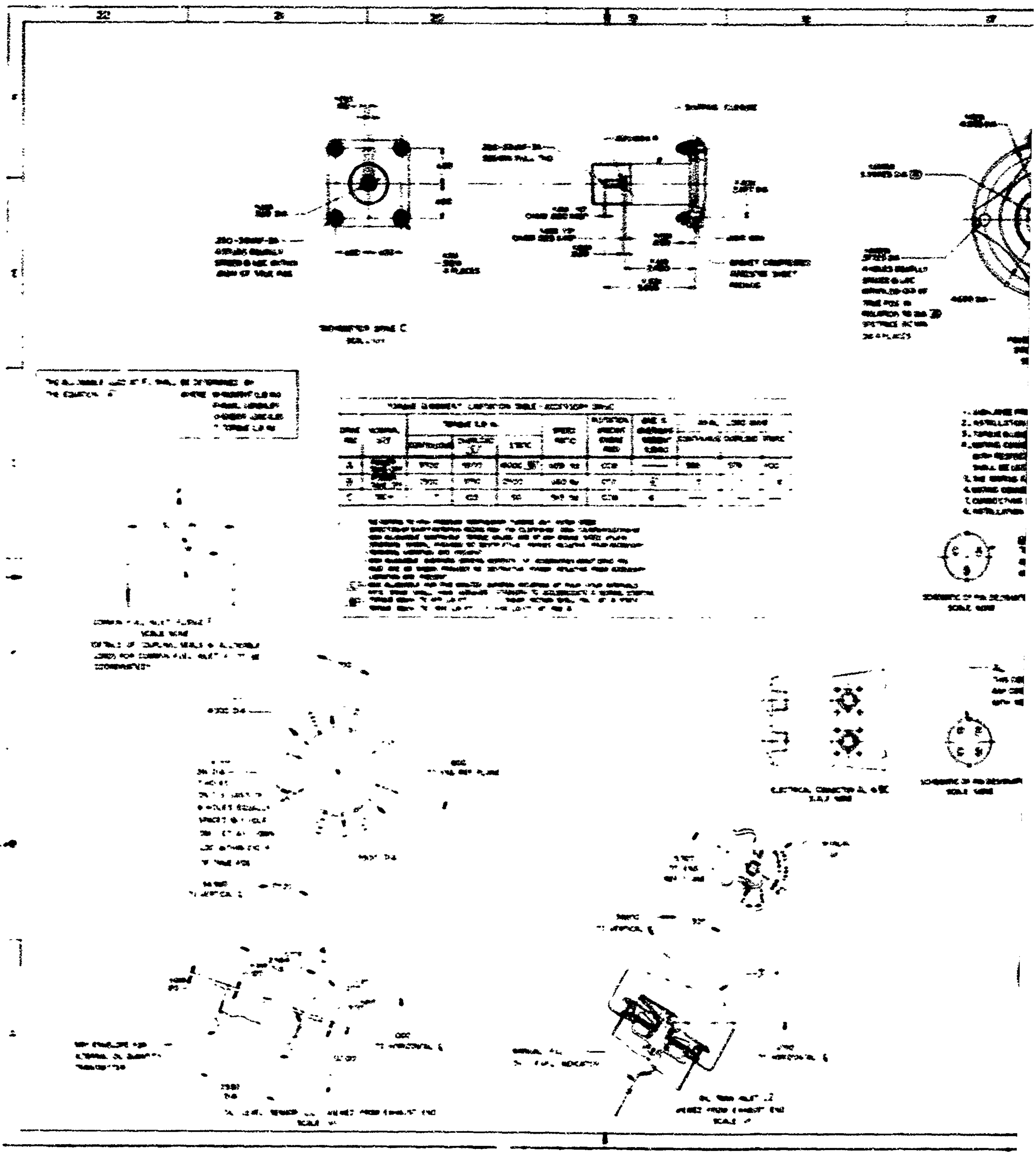
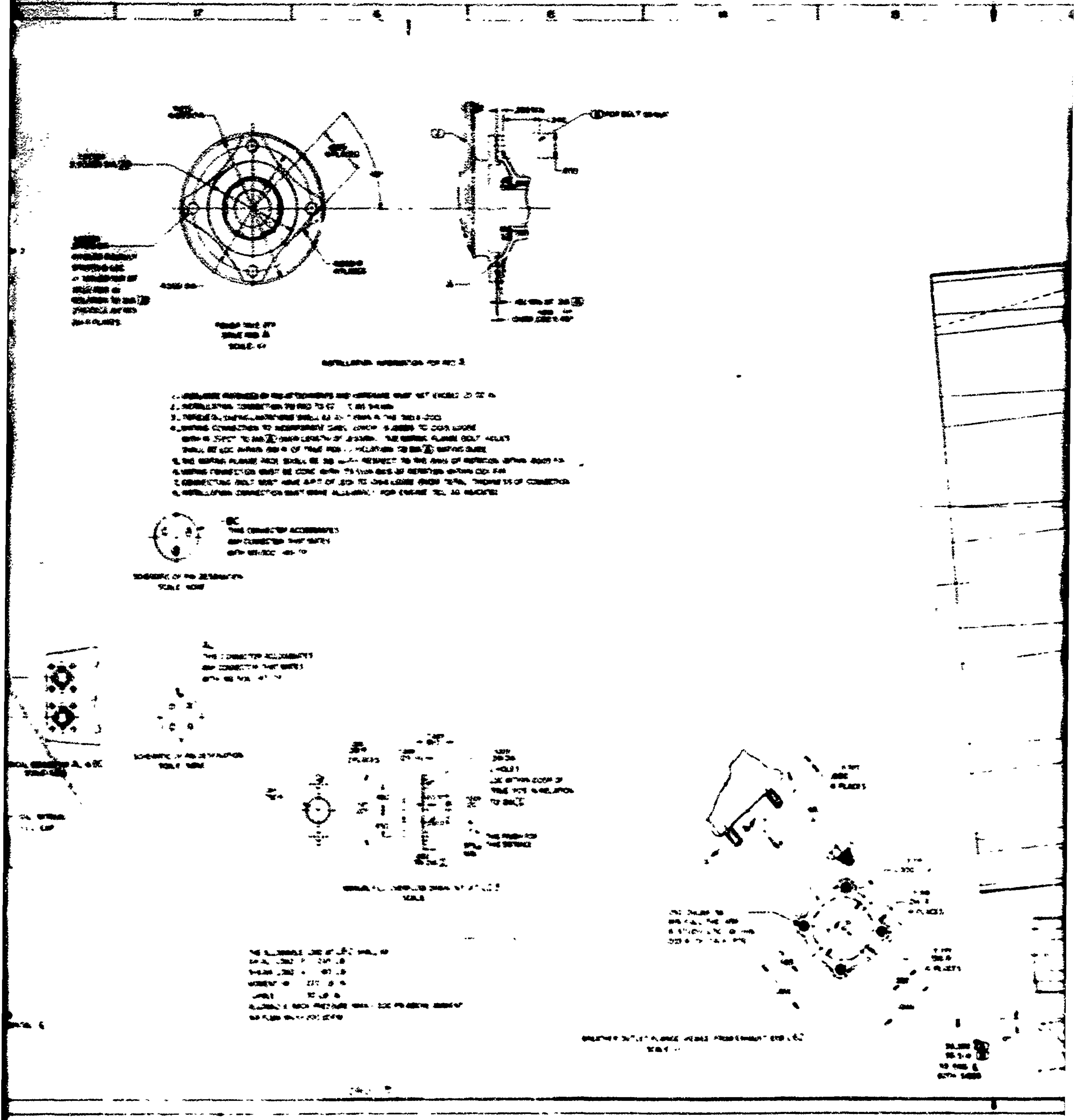
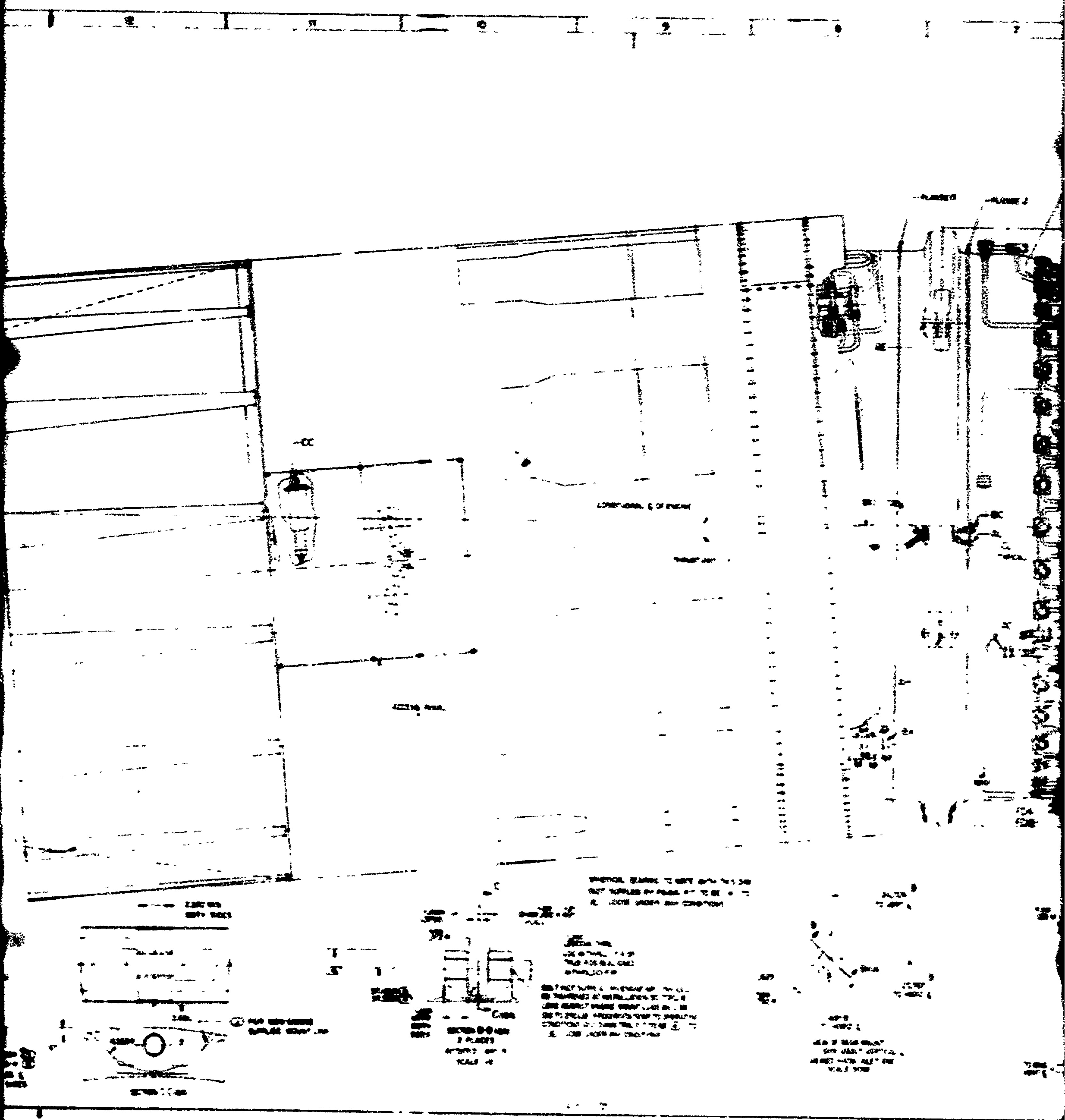
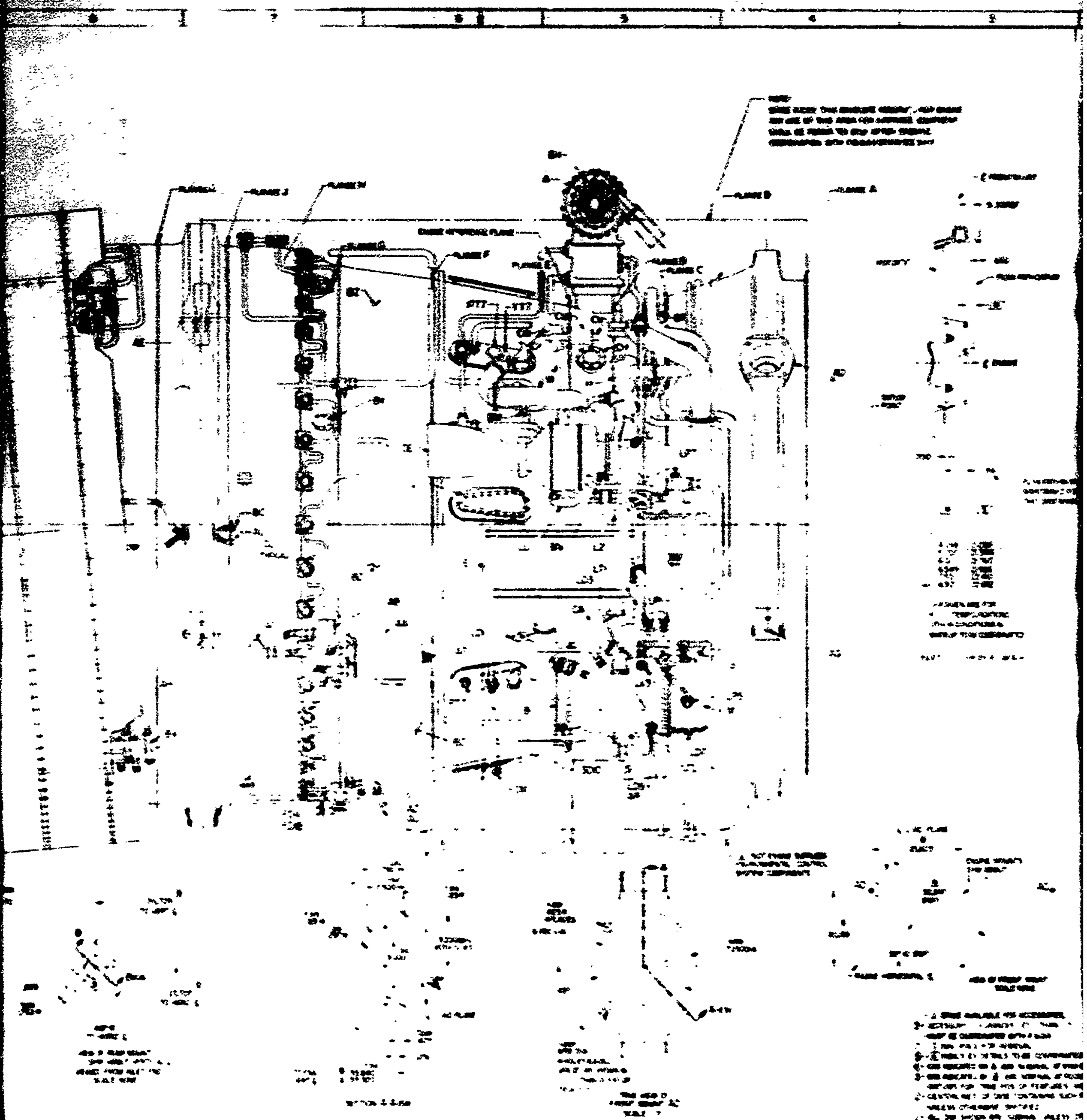


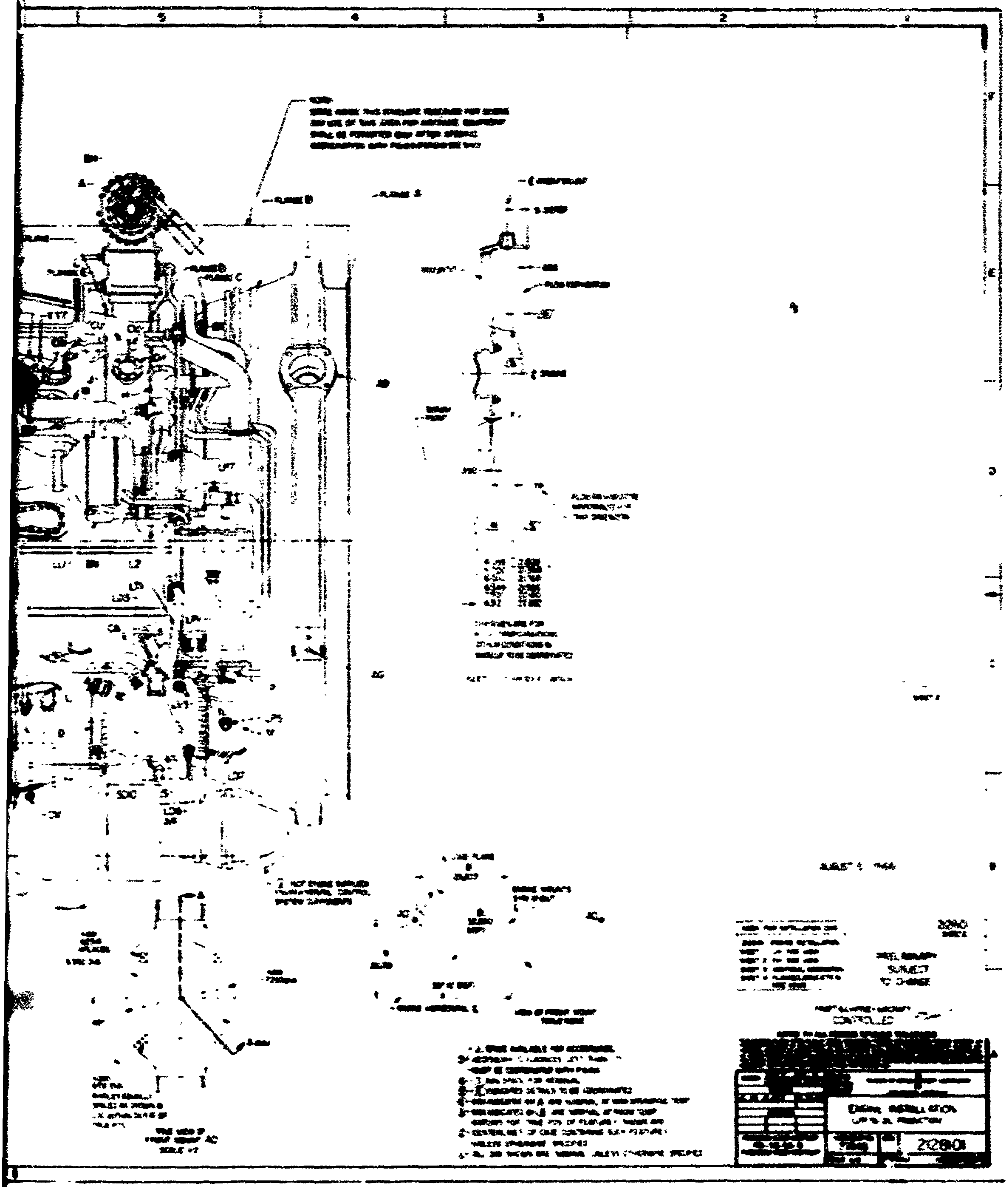

ACCESS PANEL
ENGINE INSTALLATION

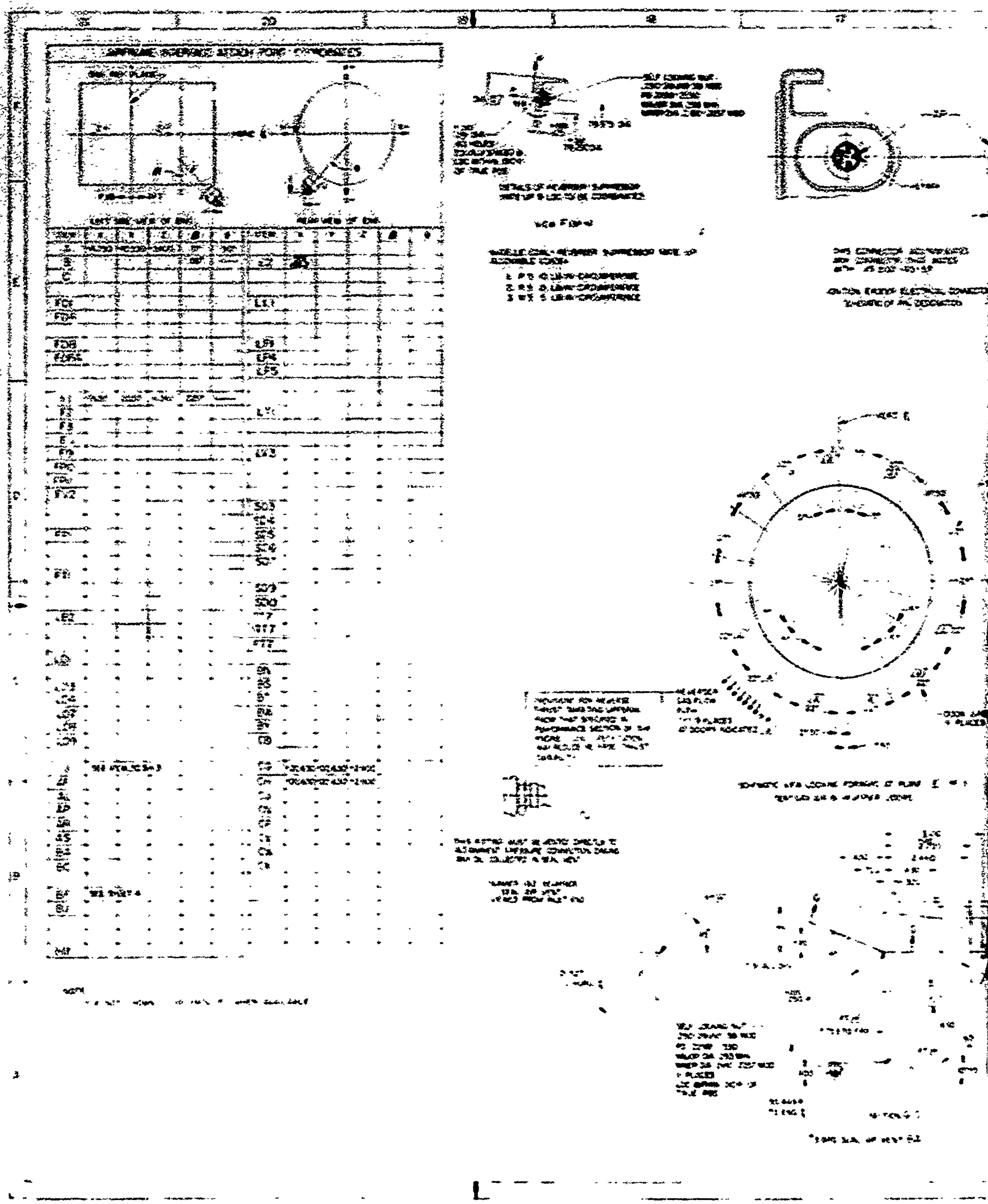


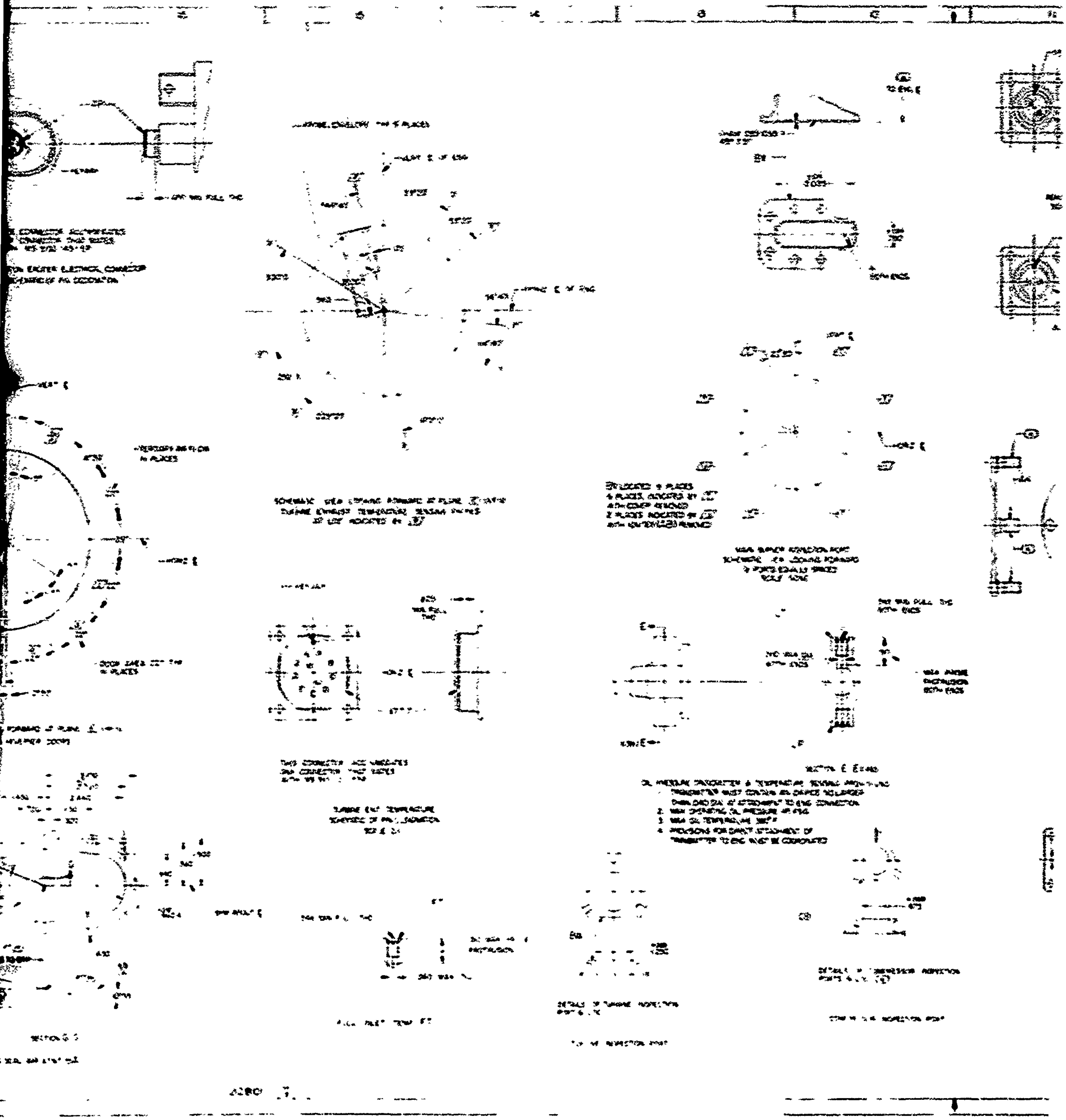


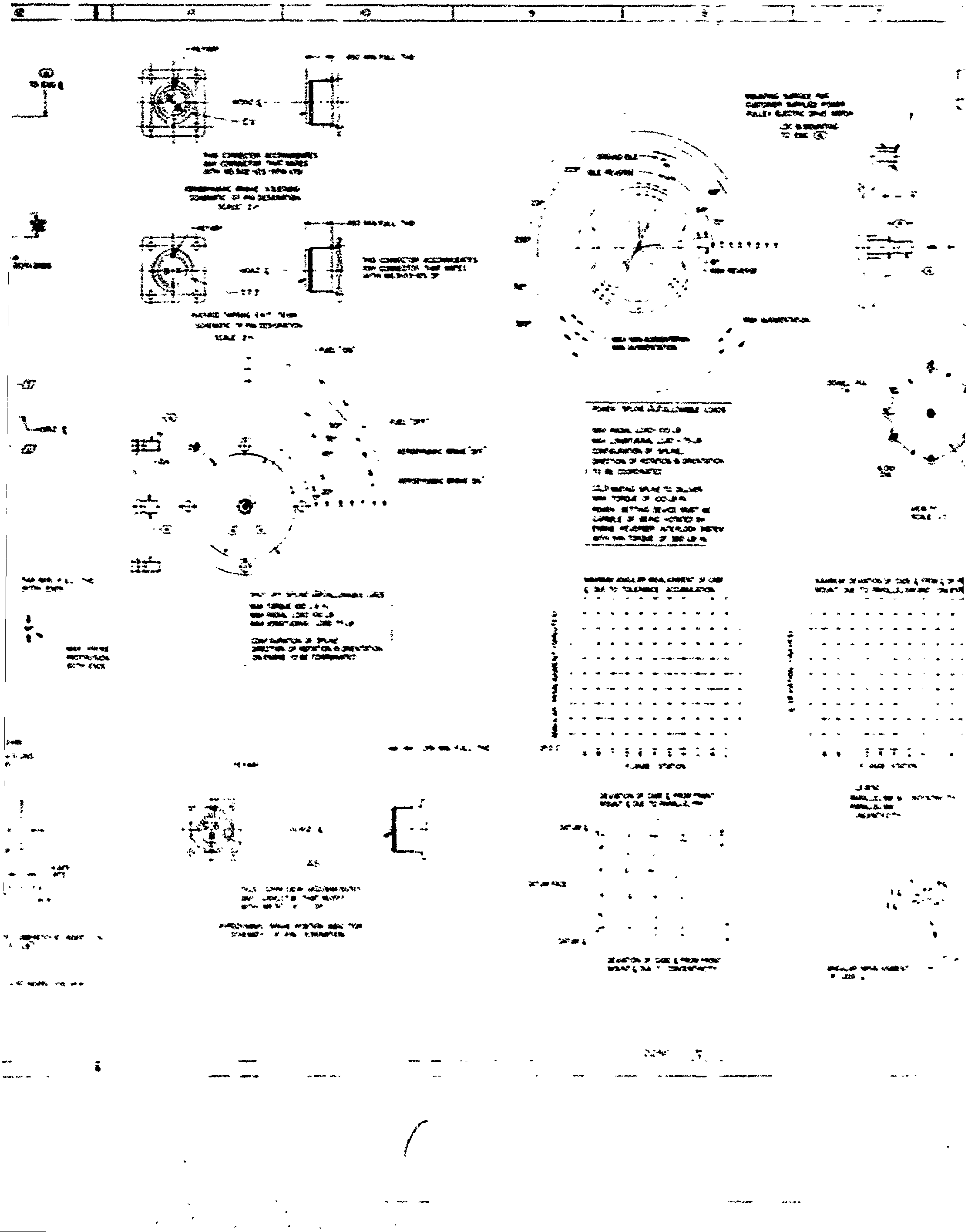


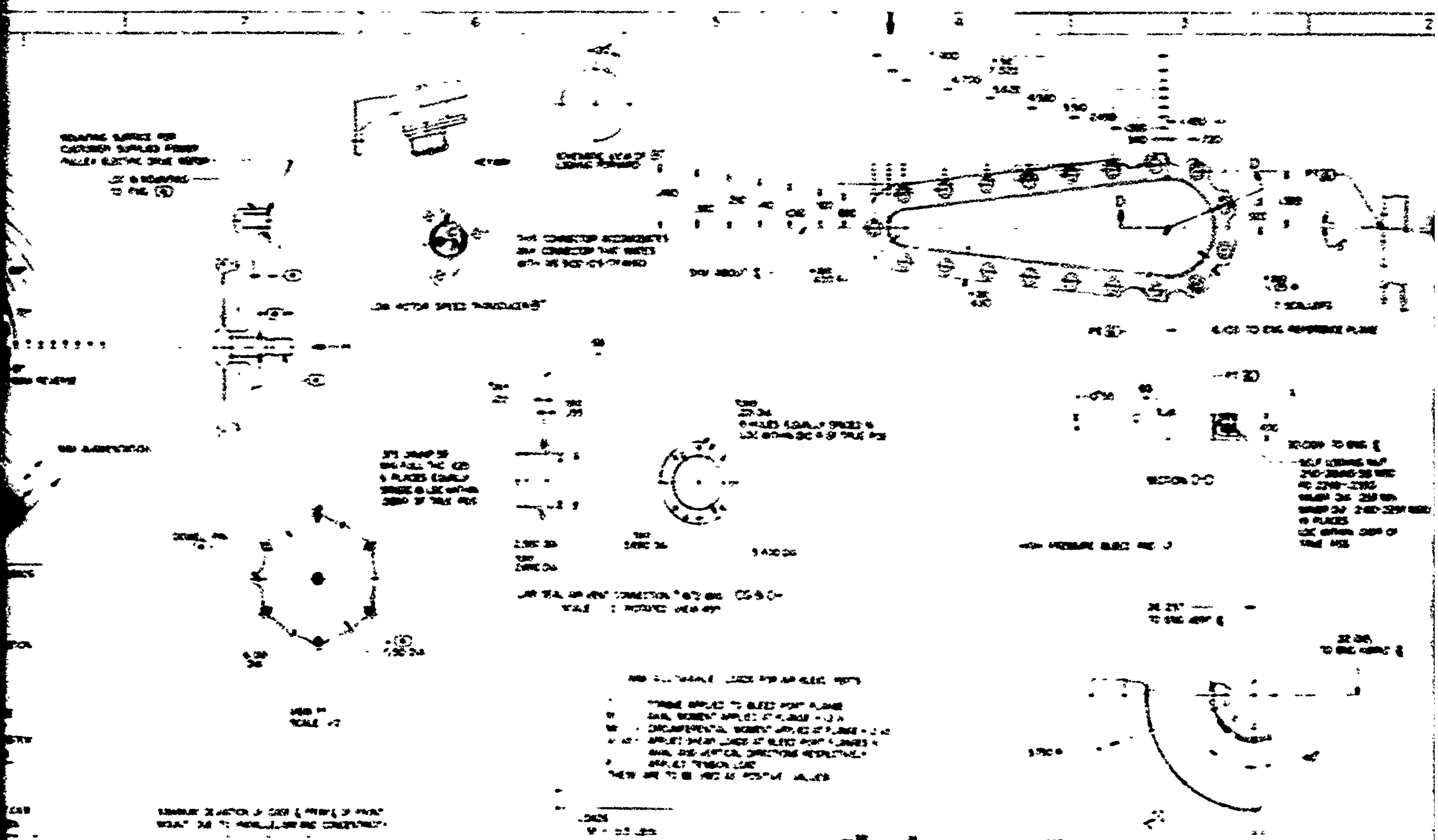


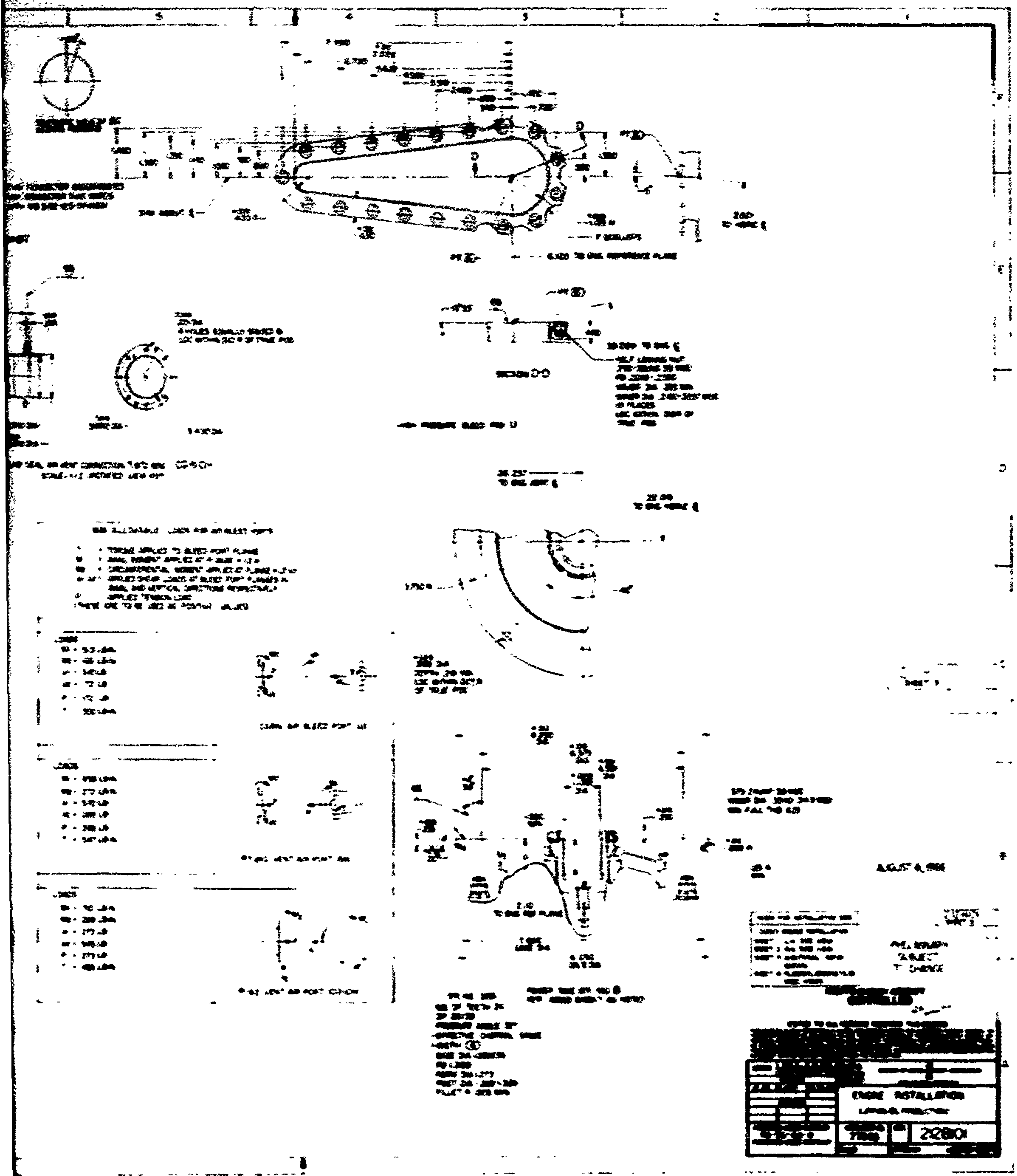






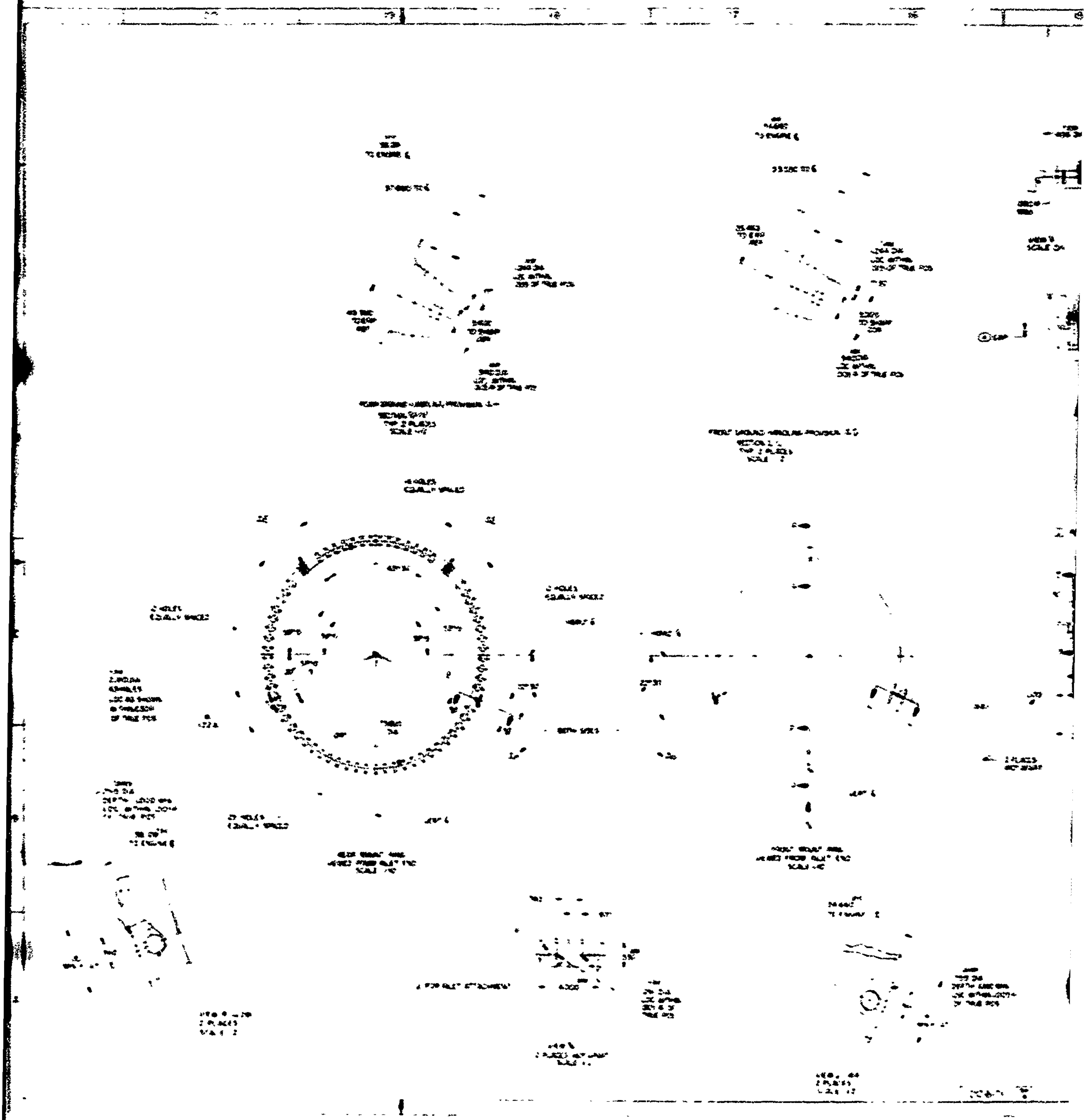




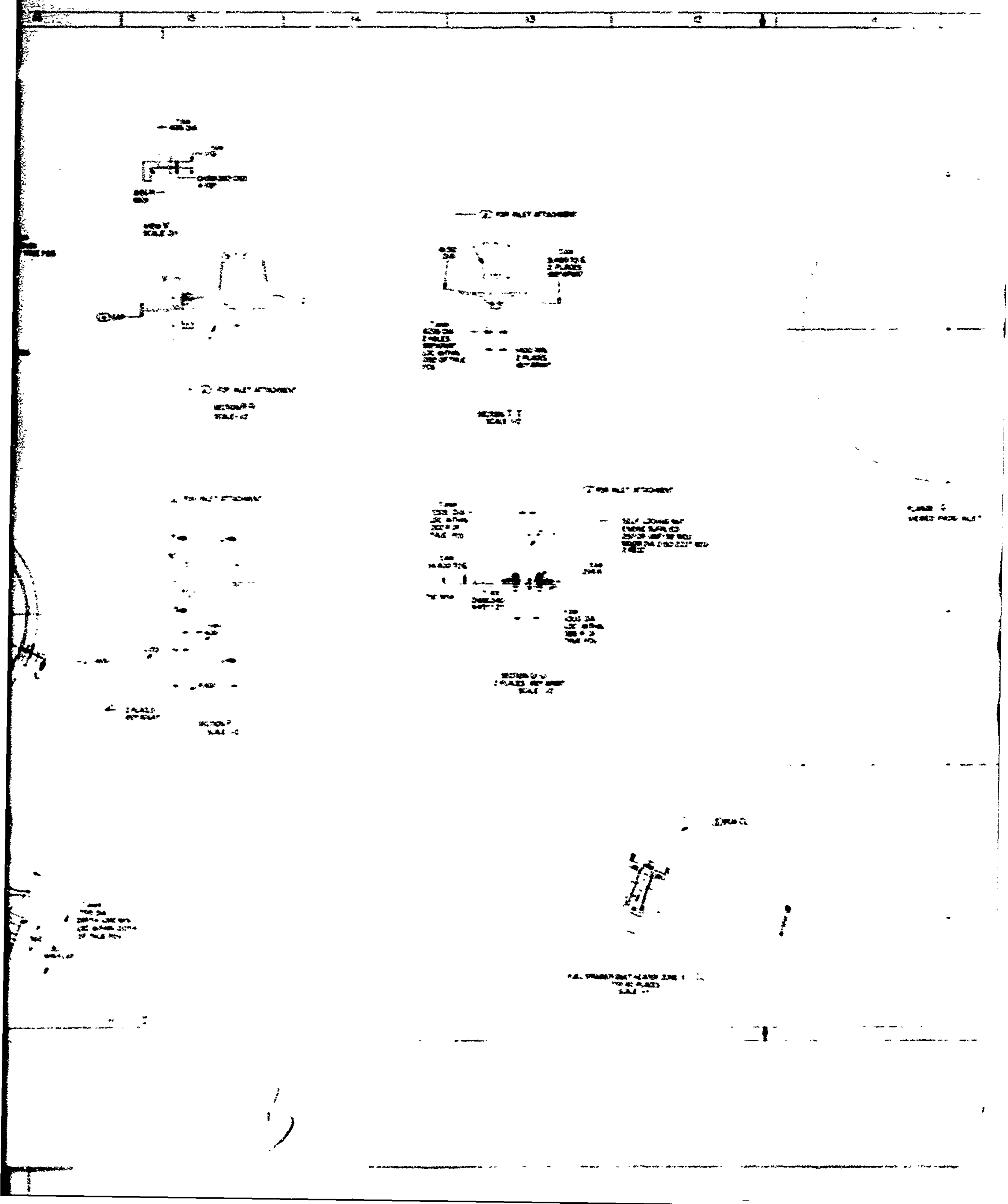


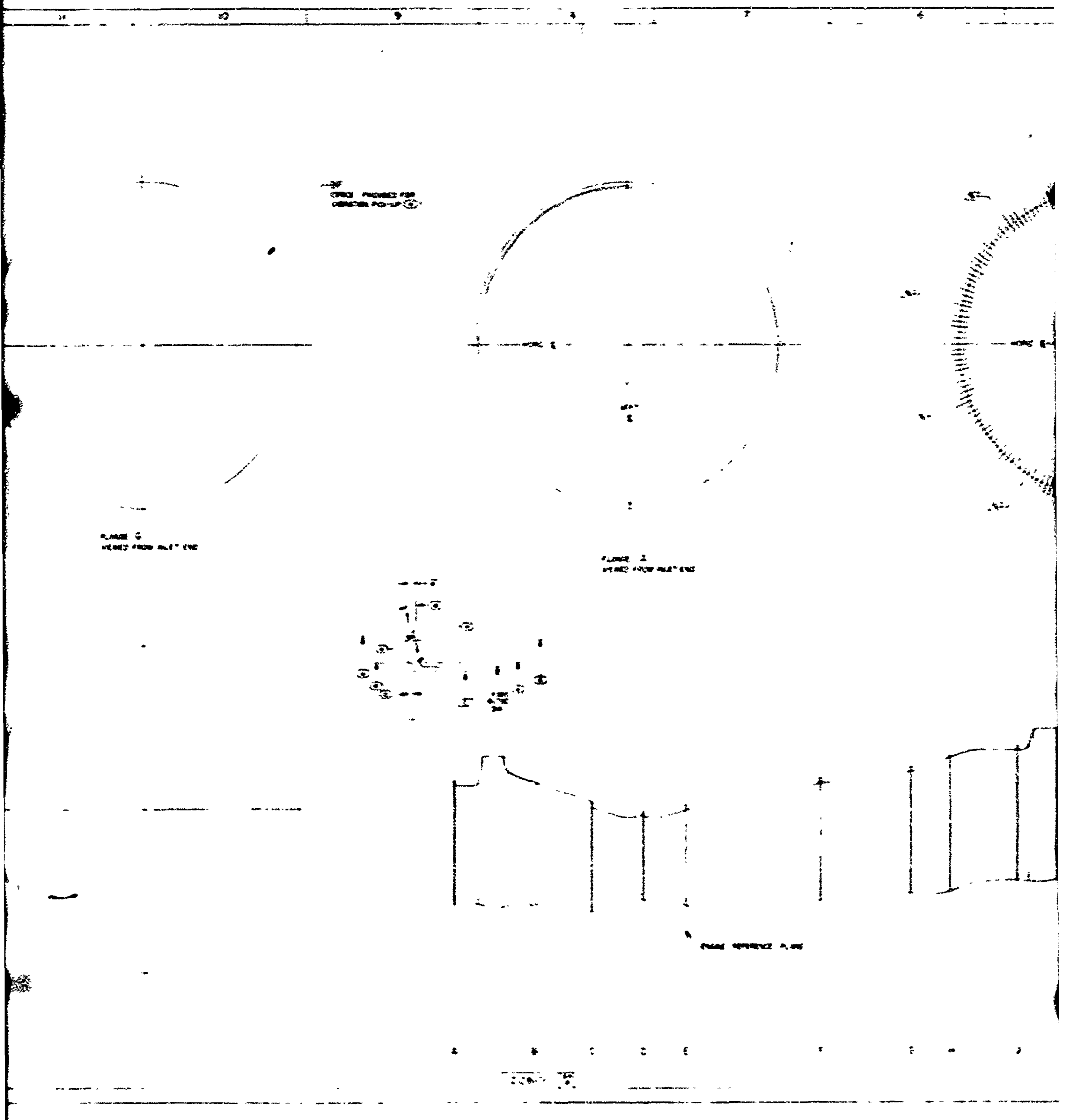
D

E

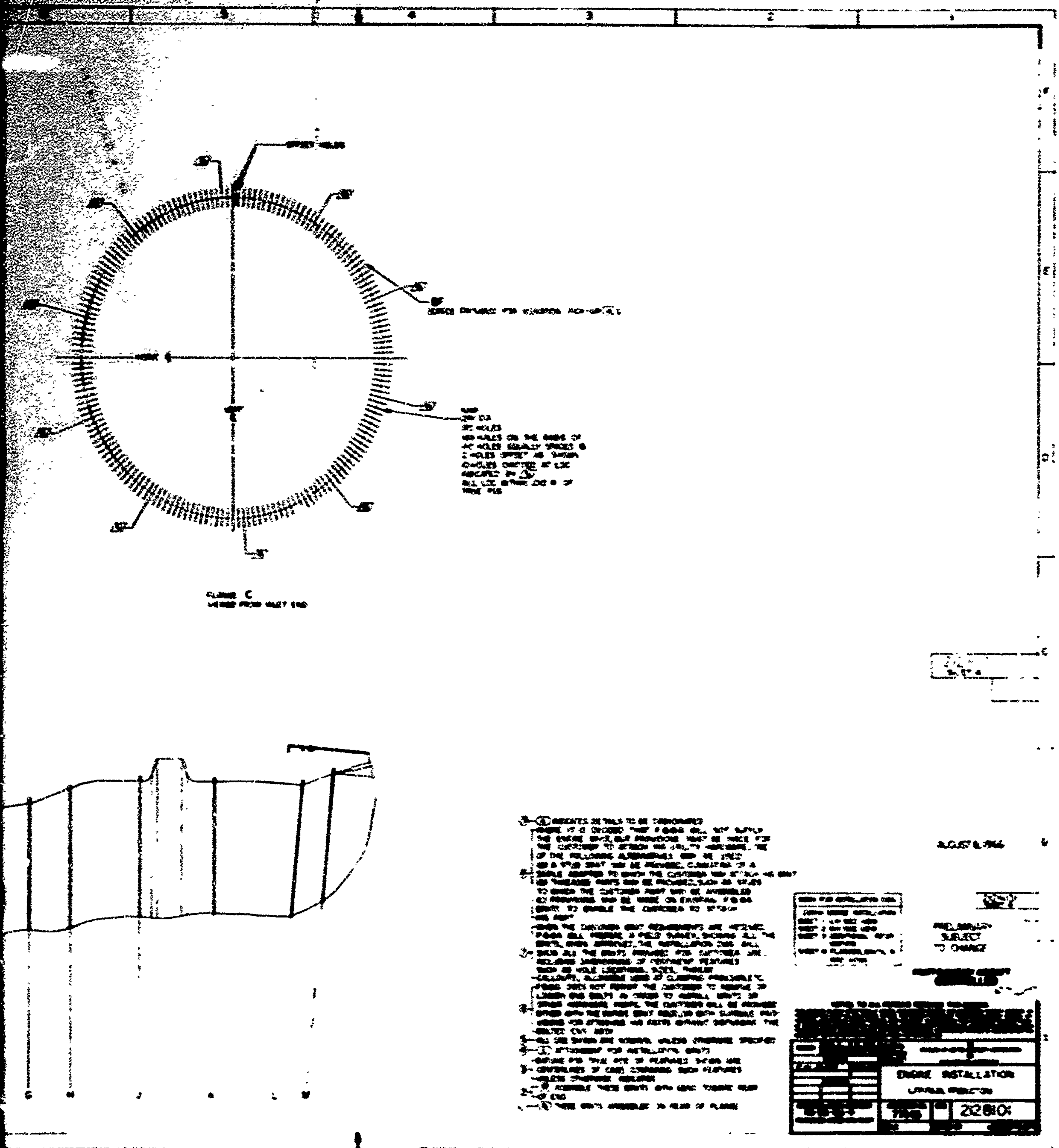


A





C


FLANGE C
ENGINE INSTALLATION
PRELIMINARY SUBJECT TO CHANGE

FLIGHT FRONT MOUNT DATA

SCHEMATIC REAR VIEW OF FRONT MOUNT

DIRECTION OF LOADS POSITIVE AS SHOWN, NEGATIVE IN OPPOSITE DIRECTION

DEFINITIONS FOR EACH MOUNT TYPE:

F = AXIAL LOAD ACTING AS SHOWN ON FRONT MOUNT ATTACHMENT

V = VERTICAL LOAD ACTING AS SHOWN ON FRONT MOUNT ATTACHMENT

H = HORIZONTAL LOAD ACTING AS SHOWN ON FRONT MOUNT ATTACHMENT

R₁, R₂, R₃ = RESULTANT LOAD NORMAL TO MOUNT SURFACES AS SHOWN

LOADS BASED ON THE FOLLOWING CONDITIONS

1. LOADS [illegible] ACTING ON FRONT MOUNT MUST BE APPLIED WITH LOAD CENTER LOCATED AT A RADIAL DISTANCE FROM ENGINE ℄ OF 32.5 ± 0.050 AND RESULTANT R₁ & R₂ UNIFORMLY DISTRIBUTED ON SURFACES AS SHOWN AND RESULTANT R₃ APPLIED WITH LOADS DISTRIBUTED TO 4 BOLTS.

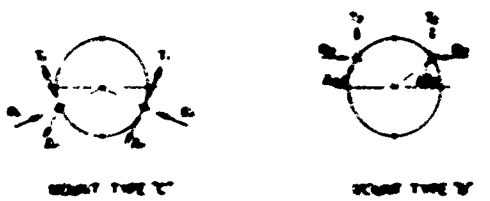
2. LOAD [illegible] ACTING ON FRONT MOUNT MAY BE APPLIED WITH LOAD CENTER LOCATED SUCH THAT RESULTANT R₃ DISTRIBUTED TO 4 BOLTS DOES NOT EXCEED 3,000 LB PER BOLT

THE ALLOWABLE LIMIT LOADS FOR EACH FRONT MOUNT ATTACHMENT MUST SATISFY ALL VALUES GIVEN BELOW. THESE LOADS REPRESENT THE MAXIMUM LOADS AT EACH LOCATION AND DO NOT OCCUR SIMULTANEOUSLY

1. [illegible] 75,000 LB 2. [illegible] 30,000 LB 3. [illegible] 20,000 LB 4. [illegible] 8,000 LB

SHIPPING & GROUND HANDLING FRONT MOUNT DATA

SCHEMATIC REAR VIEW OF FRONT MOUNT WITH DIRECTION OF LOADS POSITIVE AS SHOWN NEGATIVE IN OPPOSITE DIRECTION. AXIAL LOADS ARE POSITIVE TO REAR



DEFINITIONS FOR EACH MOUNT TYPE:

R = RADIAL LOAD ACTING ON FRONT MOUNT GROUND HANDLING ATTACHMENT

T = TANGENTIAL LOAD ACTING ON FRONT MOUNT GROUND HANDLING ATTACHMENT

A = AXIAL LOAD ACTING ON FRONT MOUNT GROUND HANDLING ATTACHMENT WITH NO OVERTURNING MOMENT

R = RADIAL GROUND HANDLING & SHIPPING LOAD ACTING ON EITHER FRONT FLIGHT ATTACHMENT

T = TANGENTIAL GROUND HANDLING & SHIPPING LOAD ACTING ON EITHER FRONT FLIGHT ATTACHMENT

A = AXIAL GROUND HANDLING & SHIPPING LOAD ACTING ON EITHER FRONT FLIGHT ATTACHMENT APPLIED WITH NO OVERTURNING MOMENT

THE GROUND HANDLING & SHIPPING ALLOWABLE LIMIT LOADS FOR FRONT MOUNT ATTACHMENT MUST SATISFY ALL VALUES GIVEN BELOW. THESE LOADS REPRESENT THE MAXIMUM LOADS AT EACH LOCATION AND DO NOT OCCUR SIMULTANEOUSLY

1. [illegible] (Ⓓ)	3. [illegible] (Ⓓ)	5. [illegible] (Ⓓ)
2. [illegible] (Ⓓ)	4. [illegible] (Ⓓ)	6. [illegible] (Ⓓ)

FLIGHT REAR MOUNT DATA

SCHEMATIC REAR VIEW OF REAR MOUNT

DIRECTION OF LOADS POSITIVE AS SHOWN, NEGATIVE IN OPPOSITE DIRECT[ION]

DEFINITIONS FOR EACH MOUNT TYPE:

A = AXIAL LOAD ACTING AS SHOWN ON REAR MOUNT ATTACHMENT APPLIED AT ℄ OF MOUNT HOLE

T = TANGENTIAL LOAD ACTING ON REAR MOUNT ATTACHMENT (BOTH FLANGES)

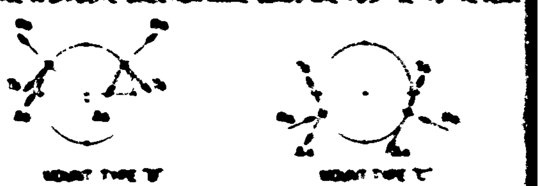
R = RADIAL LOAD ACTING ON REAR MOUNT ATTACHMENTS (BOTH FLANGES)

THE ALLOWABLE LIMIT LOADS FOR REAR MOUNT ATTACHMENT MUST SA[TISFY] ALL VALUES GIVEN BELOW. THESE LOADS REPRESENT THE MAXIM[UM] LOADS AT EACH LOCATION AND DO NOT OCCUR SIMULTANEOUSLY

1. [illegible] 72,000 LBS 2. [illegible] (Ⓐ) 3. [illegible] (Ⓐ)

SHIPPING & GROUND HANDLING REAR MOUNT DATA

SCHEMATIC REAR VIEW OF REAR MOUNT WITH DIRECTION OF LOADS POSITIVE AS SHO[WN] NEGATIVE IN OPPOSITE DIRECTION. AXIAL LOADS ARE POSITIVE TO THE REAR



DEFINITIONS FOR EACH MOUNT TYPE

A = AXIAL LOAD ACTING ON EITHER REAR MOUNT GROUND HANDLING AT[TACHMENT]

T = TANGENTIAL LOAD ACTING ON EITHER REAR MOUNT GROUND HANDLING AT[TACHMENT]

R = RADIAL LOAD ACTING ON EITHER REAR MOUNT GROUND HANDLING AT[TACHMENT]

A = AXIAL GROUND HANDLING & SHIPPING LOAD ACTING ON EITHER REAR [FLIGHT] ATTACHMENT APPLIED AT ℄ OF HOLE WITH NO OVERTURNING MOME[NT] (TO BE TAKEN BY SINGLE FLANGE)

T = TANGENTIAL GROUND HANDLING & SHIPPING LOAD ACTING ON EITHE[R] FLIGHT ATTACHMENT (BOTH FLANGES)

R = RADIAL GROUND HANDLING & SHIPPING LOAD ACTING ON EITHER RE[AR] FLIGHT ATTACHMENT (BOTH FLANGES)

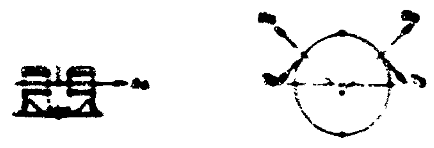
THE GROUND HANDLING & SHIPPING ALLOWABLE LIMIT LOADS FOR REA[R] ATTACHMENT MUST SATISFY ALL VALUES GIVEN BELOW. THESE LO[ADS] REPRESENT THE MAXIMUM LOADS AT EACH LOCATION AND DO NOT [OCCUR] SIMULTANEOUSLY

1. [illegible] (Ⓔ)	3. [illegible] (Ⓔ)	5. [illegible] (Ⓔ)
2. [illegible] (Ⓔ)	4. [illegible] (Ⓔ)	6. [illegible] (Ⓔ)

Ⓓ - Ⓔ VALUES TO BE COORDINATED

[illegible]

FLIGHT REAR MOUNT DATA
SCHEMATIC REAR VIEW OF REAR MOUNT
DIRECTION OF LOADS POSITIVE AS SHOWN, NEGATIVE IN OPPOSITE DIRECTION



MOUNT TYPE "A"

DEFINITIONS FOR EACH MOUNT TYPE:
Aa-AXIAL LOAD ACTING AS SHOWN ON REAR MOUNT ATTACHMENT APPLIED AT ℄ OF MOUNT HOLE
Ta-TANGENTIAL LOAD ACTING ON REAR MOUNT ATTACHMENT (BOTH FLANGES)
Ra-RADIAL LOAD ACTING ON REAR MOUNT ATTACHMENTS (BOTH FLANGES)

THE ALLOWABLE LIMIT LOADS FOR REAR MOUNT ATTACHMENT MUST SATISFY ALL VALUES GIVEN BELOW. THESE LOADS REPRESENT THE MAXIMUM LOADS AT EACH LOCATION AND DO NOT OCCUR SIMULTANEOUSLY.

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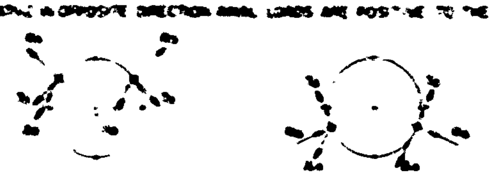
SHIPPING & GROUND HANDLING REAR MOUNT DATA
SCHEMATIC REAR VIEW OF REAR MOUNT WITH DIRECTION OF LOADS POSITIVE AS SHOWN NEGATIVE IN OPPOSITE DIRECTION. AXIAL LOADS ARE POSITIVE TO THE REAR



MOUNT TYPE "B" MOUNT TYPE "C"

DEFINITIONS FOR EACH MOUNT TYPE
Aa-AXIAL LOAD ACTING ON EITHER REAR MOUNT GROUND HANDLING ATTACHMENT
Ta-TANGENTIAL LOAD ACTING ON EITHER REAR MOUNT GROUND HANDLING ATTACHMENT
Ra-RADIAL LOAD ACTING ON EITHER REAR MOUNT GROUND HANDLING ATTACHMENT
Aa-AXIAL GROUND HANDLING & SHIPPING LOAD ACTING ON EITHER REAR FLIGHT ATTACHMENT APPLIED AT ℄ OF HOLE WITH NO OVERTURNING MOMENT (LOAD TO BE TAKEN BY SINGLE FLANGE)
Ta-TANGENTIAL GROUND HANDLING & SHIPPING LOAD ACTING ON EITHER REAR FLIGHT ATTACHMENT (BOTH FLANGES)
Ra-RADIAL GROUND HANDLING & SHIPPING LOAD ACTING ON EITHER REAR FLIGHT ATTACHMENT (BOTH FLANGES)
THE GROUND HANDLING & SHIPPING ALLOWABLE LIMIT LOADS FOR REAR MOUNT ATTACHMENT MUST SATISFY ALL VALUES GIVEN BELOW. THESE LOADS REPRESENT THE MAXIMUM LOADS AT EACH LOCATION AND DO NOT OCCUR SIMULTANEOUSLY.

AUG 9, 1966

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PRELIMINARY
SUBJECT
TO CHANGE

LOAD INSTALLATION ALLOWABLE FLIGHT SHIPPING & GROUND HANDLING

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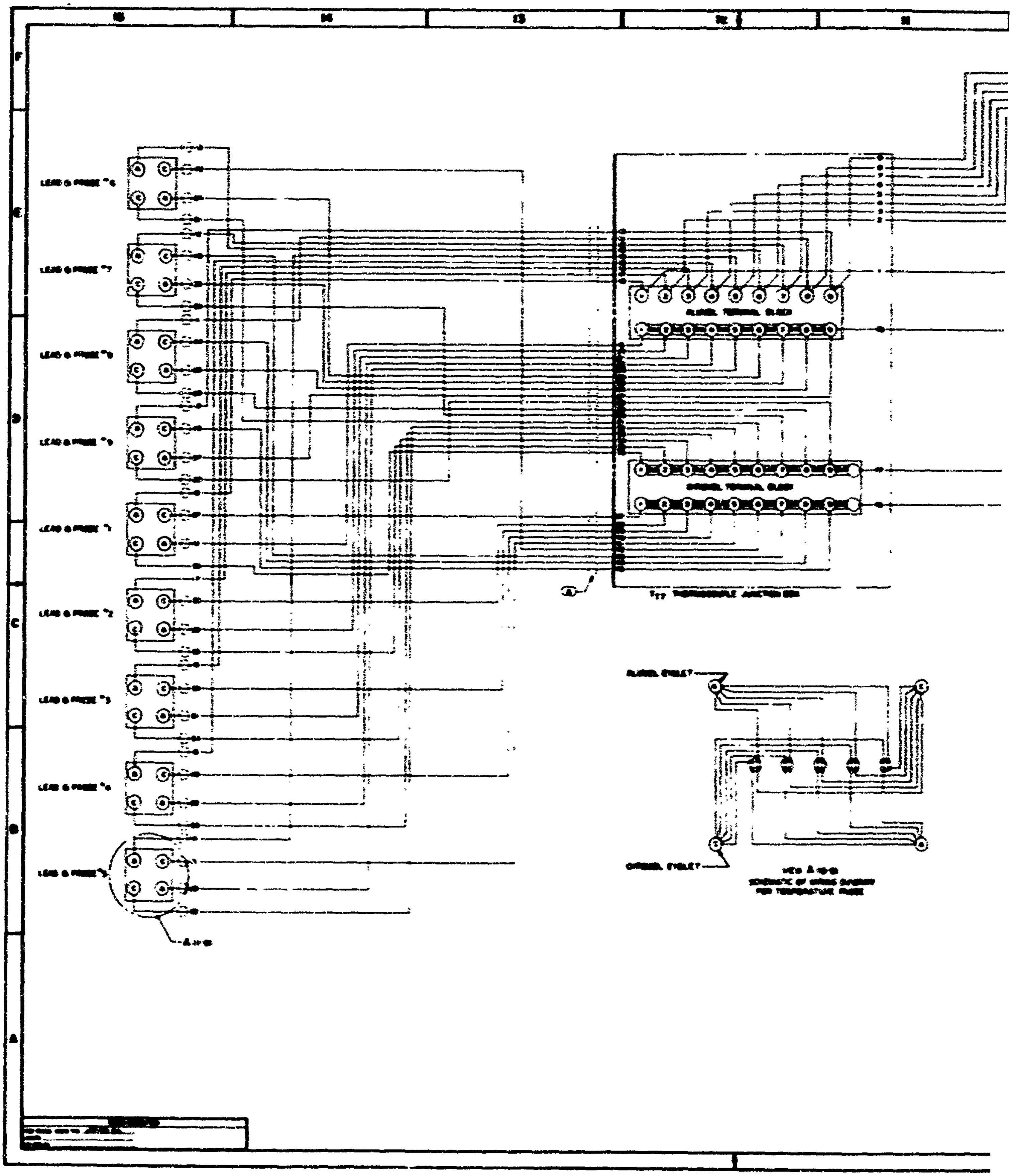
VALUES TO BE COORDINATED



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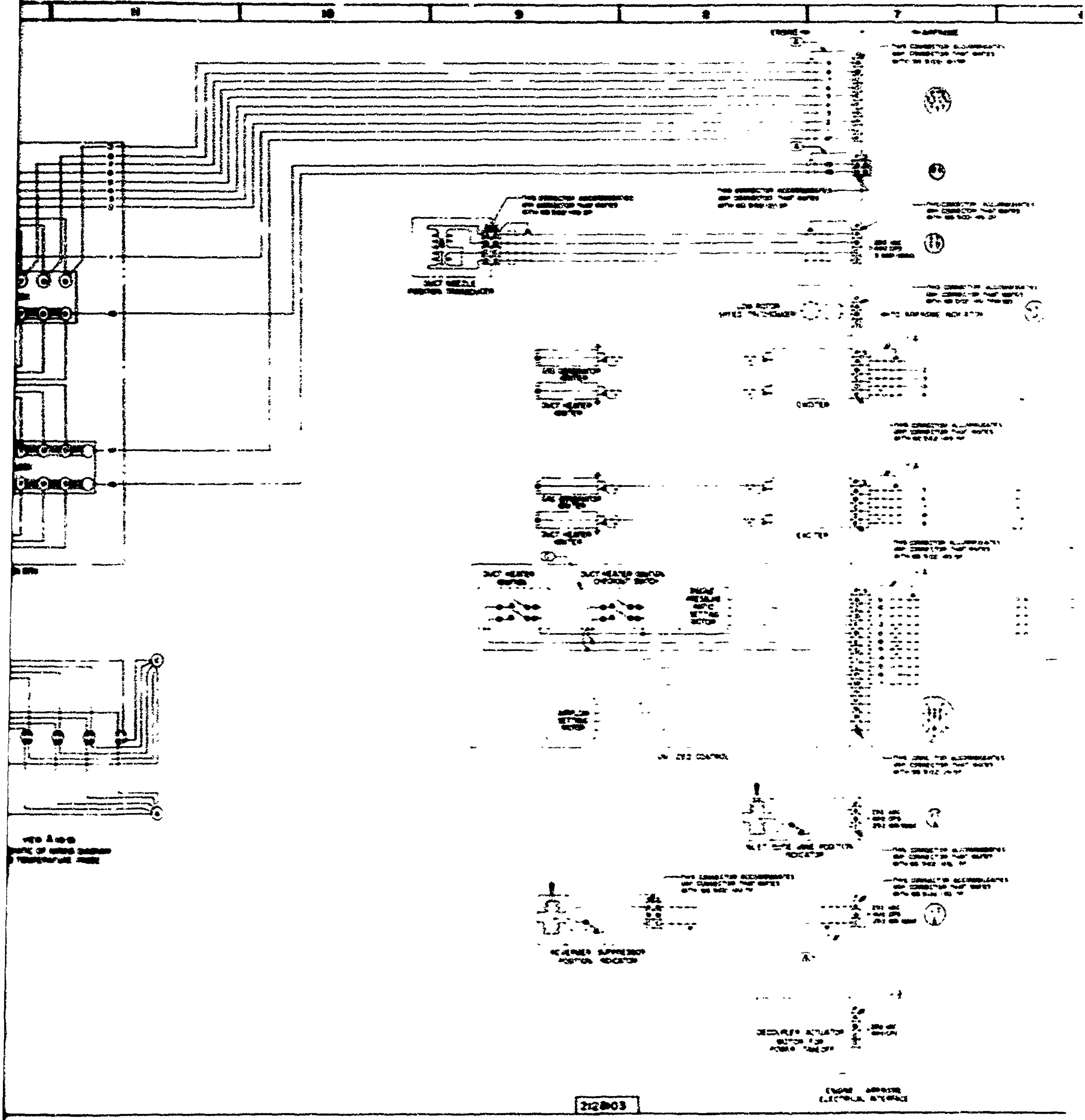
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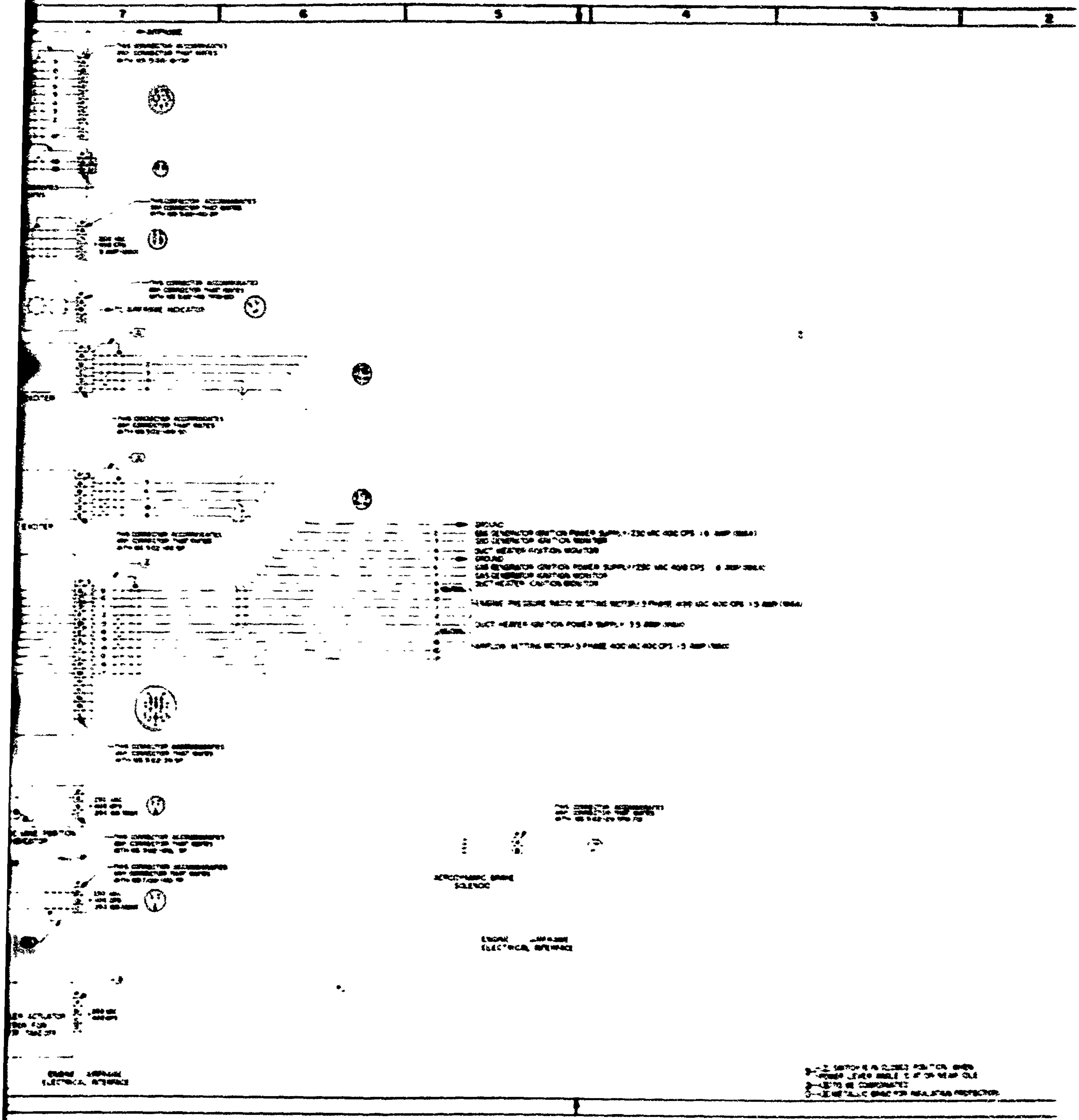

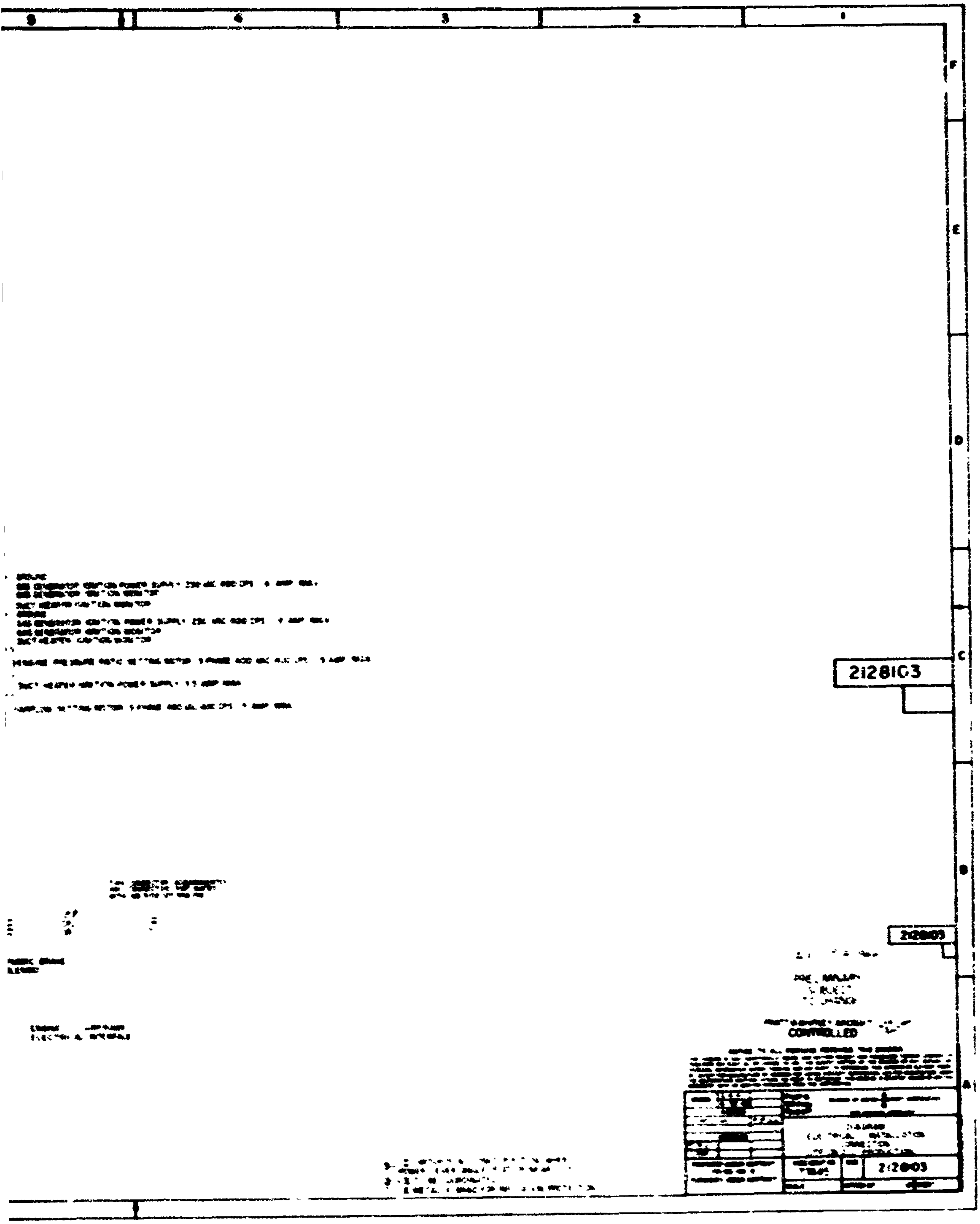
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APPENDIX A

1.0 SCOPE

1.1 Scope - This appendix establishes the requirements for the Flight Test Status (FTS) engines to be delivered under Phase III of the Supersonic Transport Program. The engines will be in general accordance with the requirements of Model Specification No. 2698A except as modified in this appendix.

3.1.1 Dimension and Installation Drawing - Change the Engine Installation Drawing No. to 2130201.

Add the following paragraph:

"3.2.2 Dry Weight of Engine - The dry weight of the FTS engine shall be within 3% of the total dry weight specified in 3.2."

6.1 Performance Ratings - Add the following sentences: "The specified engine thrusts and thrust specific fuel consumptions (TSFC) for the FTS engine shall be as specified in table I, table II, and table IIA within 3% and 5%, respectively. If the thrust is less than the production rating, provisions shall be made for limited time operation at production thrust levels to accomplish Phase III airplane performance demonstration."

24.0 ENGINE NOISE LEVELS - Add the following sentence: "The specified noise values shall be objectives for the Phase III program."

28.0 ENGINE TYPE CERTIFICATION TEST - Replace 28.0 with the following paragraphs:

28.0 "ENGINE FLIGHT TEST STATUS - Engine Flight Test Status shall be accomplished by satisfactory completion of sea level and altitude tests in accordance with 28.2.2.2.2.1 through 28.2.2.2.2.4.

28.1 Test Approval - The engine shall be considered to have satisfactorily completed these tests if, at the completion of the engine recalibration specified in 28.2.2.2.3.1 it is within the specified limits and the engine is still in operational condition as substantiated by conducting a final acceptance test run in accordance with the schedule specified in 29.0.

28.1.1 Reports

28.1.1.1 Test Reports - Following completion of each separate engine or component test, or consecutive group of tests conducted on any single test assembly or components, a report shall be submitted.

28.1.1.1.1 Preparation - These reports shall contain essentially the following items:

a. Cover (Title of report, number of the report, source of report, date, name(s) of the author(s) and contract number).
b. Title page (Title of report, number of the report, source of the report, date, name(s) of the author(s), and contract number).
c. Abstract (A brief statement of the contents of the report, including the objective).
d. Table of contents.
e. List of illustrations (Provide figure numbers and captions of all illustrations. Photographs, charts, and graphs should be treated as illustrations and given figure numbers. When used in a separate series, tables should be given Roman numerals. Examples: figure 1, figure 2, etc.; table I, table II, etc..
f. Summary (A brief resume of the test conducted including objectives, procedures, results, conclusions, and recommendations).
g. Body of the report.
   1. Brief general description of the engine or of the component(s) and a detailed description of all features which differ from the previous model, if applicable.
   2. If approval is being requested, without test, based on similarity to a component or assembly for which previous test approval was obtained, any physical or functional dissimilarities or differences in testing requirements with respect to the test component and reference to the approved component test report shall be included.
   3. Method of test (general description of test facility, equipment and methods used in conducting the test).
   4. Record of test (chronological history of all events in connection with all of the testing).
   5. Analysis of results (a complete discussion of all phases of the test, such as probable reasons for failure and unusual wear, comparison in performance with previous models, and analysis of general operation).
   6. Calibration and recalibration data including acceptance limits (data in both uncorrected and corrected form, if applicable, shall be shown by suitable curves).
   7. Tabulated data of all pertinent instrument readings and all required instrument readings taken during the test. Extraneous readings, which P&WA may desire to take during the test, need not be reported.
   8. Description of the condition of the engine or components at disassembly inspection.
   9. Conclusions and recommendations.

28.1.1.1.2 Number and Distribution of Copies - Five copies of the report shall be forwarded to the Federal Aviation Agency.

28.2 Quality Assurance Provisions

28.2.1 General - Turbofan aircraft engines, components, and test apparatus shall be subject to inspection by authorized Government representatives who shall be given all reasonable facilities to determine conformance with this specification. All instructions for testing of the engine shall be available to the Government representative.

28.2.1.1 Accuracy of Data - Automatic recording equipment and associated test apparatus required to evaluate engine variables versus time shall have a static accuracy within 2% of the values obtained at the maximum rating of the engine. The accuracy of transient data and the corresponding instrument calibration methods shall be subject to review by the authorized Government representative and shall be described in the Flight Test Status report. All instruments and equipment shall be calibrated as necessary to insure that the required degree of accuracy is maintained.

28.2.2 Engine Tests

28.2.2.1 Test Conditions - The following conditions shall apply for all engine tests unless otherwise specified.

28.2.2.1.1 Test Apparatus

28.2.2.1.1.1 Automatic Recording Equipment - Automatic continuous recording equipment shall be used to record data during the execution of that part of the engine tests (see 28.2.2.2.1.3, 28.2.2.2.2.3, 28.2.2.2.2.5.2, 28.2.2.2.2.5.3, and 28.2.2.2.3.1) requiring the evaluation of time versus engine variables.

28.2.2.1.1.2 Vibration Measurement Equipment - The vibration equipment used for measurement of engine case vibration shall have frequency response characteristics similar to the response characteristics of equipment used on previously Type Certificated engines.

28.2.2.1.2 Preliminary Data - The engine weight and center of gravity, if not previously obtained, photographs, and other pertinent engine data shall be obtained preferably at the time the engine is being prepared for test.

28.2.2.1.3 Operating Test Conditions

28.2.2.1.3.1 Inlet Distortion - All operation during the tests specified in 28.2.2.2.2.1 and 28.2.2.2.2.2 shall be with representative inlet distortion patterns, within facility limitations, as determined by airframe inlet tests but not to exceed the distortion limits specified in 10.0(a).

28.2.2.1.3.2 Oil Inlet Temperature - For all operation during the tests specified in 28.2.2.2.2.2, the main oil temperature at the location designated on the Installation Drawing shall be self-regulating.

28.2.2.1.3.3 Oil Servicing - The oil system shall be drained and filled with new oil at the start of the specific engine test. The use of external oil filters shall not be permitted. The oil system shall be further maintained in accordance with the requirements of P&WA.

28.2.2.1.3.4 Accreditable Test Time - Test time shall not be credited by increments shorter than 15 minutes, except when shorter periods are a test requirement.

28.2.2.1.3.5 Vapor Pressure Data - Wet and dry bulb air temperature readings shall be taken at intervals not exceeding 3 hours.

28.2.2.1.3.6 Barometer Readings - The barometer shall be read and recorded at intervals not exceeding 3 hours.

28.2.2.1.3.7 Miscellaneous Data - The date, operating schedule, engine model designation, and serial number shall be recorded on each log sheet.

28.2.2.1.3.8 Test Notes - Notes shall be placed on the log sheets of all incidents of the run, such as leaks, vibration, and other irregular functioning of the engine or the equipment, and corrective measures taken.

28.2.2.1.3.9 Correction - Readings of thrust, rpm, airflow rate, fuel flow rate, specific fuel consumption, gas pressures, and gas temperatures shall be corrected to standard sea level atmospheric conditions as defined in 1962 U.S. Standard Atmosphere (Geometric) conditions. In order to determine conformance with the engine performance ratings, the corrected thrust and specific fuel consumption shall be determined for all rated conditions by P&WA standard analytical and correction procedures.

28.2.2.1.3.9.1 Barometer Correction for Temperature - The barometer shall be corrected for temperature.

28.2.2.2 Endurance Test

28.2.2.2.1 Calibrations and Checks - Performance during calibrations and checks shall meet the requirements specified herein. Operating time during calibrations shall be limited to the minimum practicable.

28.2.2.2.1.1 Electrical and Electronic Interference and Susceptibility Check - An interference and susceptibility check in accordance with 18.2 shall be made on all electrical and electronic components or systems of the test engine prior to initiation of the flight test status test. Solenoid valves and position indicator switches shall not be contributing interference since the interference duration is approximately 1 second and will have an infrequent recurrence rate.

28.2.2.2.1.2 Engine Control System Calibration - Prior to the initiation of the engine calibration specified in 28.2.2.2.1.3, the components of the engine control system shall undergo bench calibration using test fluid in accordance with the specification fuel to determine conformance with the design tolerance range required by P&WA. The calibration shall include a measurement of power lever torque.

28.2.2.2.1.3 Engine Calibration - The procedure during the engine calibration shall be such as to establish the sea level static performance characteristics of the complete turbofan engine prior to the endurance run. Calibrations shall be made with a P&WA bellmouth, no accessory power extraction, without loading the accessory drives, and with no compressor bleed airflow other than that required for continuous engine operation, except where specified. The following data shall be obtained:

a. Steady state data: Data required to establish compliance with applicable sea level peformance characteristics covered by table I.
b. Transient data: Data required to demonstrate engine starting and thrust transients.
c. Repeat items "a" and "b" above with maximum permissible compressor bleed airflow, to determine the effect of air bleed on engine performance.

28.2.2.2.2 Procedure - Following the calibration run, the control shall be adjusted to produce at least the takeoff rated thrust with the power lever in the takeoff thrust position. During the test the engine shall be adjusted as necessary to maintain the rated thrust. The test shall be conducted in accordance with 28.2.2.2.2.1 and 28.2.2.2.2.2. P&WA may establish the order of runs in each cycle to accommodate best utilization of the test facility. The time for changing thrust shall be charged to the duration time at the lower setting. For all power lever movements, the power lever shall be advanced or retarded, as applicable, in not more than 1 second during the applicable test specified in 28.2.2.2.2.1 and 1 minute during the applicable test specified in 28.2.2.2.2.2.

28.2.2.2.2.1 Part 1 - The 25-hour sea level endurance test shall consist of 5 cycles of 5 hours each to be conducted in accordance with the schedule listed below and as shown on figure A-1. At least 2 of these cycles shall be at the maximum specified fuel inlet pressure. The 2nd cycle shall be accomplished with 3% gas generator bleed airflow. All other cycles shall be with no compressor air bleed flow other than that required for continuous engine operation.

a. Takeoff thrust run - Thirty minutes consisting of five 6-minute periods, in each of which 5 minutes shall be run with the power lever in the Takeoff Augmented thrust position, and 1 minute with the power lever in the 95% Takeoff Nonaugmented thrust position.
b. Cruise augmented thrust run - One hour with the sea level power setting corresponding to Cruise Partially Augmented thrust (reference table II).

c. Takeoff Augmented thrust - Idle thrust run - Thirty minutes consisting of five 6-minute periods, in each of which 4 minutes shall be run with the power lever in the Takeoff Augmented thrust position, and 2 minutes with the power lever in the Idle thrust position.
d. 95% Takeoff Nonaugmented thrust run - Forty-five minutes with the power setting corresponding to 95% Takeoff Nonaugmented thrust.
e. 85% Takeoff Nonaugmented thrust run - Twenty-one minutes with the power lever in the position corresponding to 85% Takeoff Nonaugmented thrust.
f. Reverse thrust run - Nine minutes in the sequence of power lever positions and time durations as follows: 1 minute Idle, 1 minute Maximum Reverse thrust, 6 minutes alternating 1 minute each at Takeoff Augmented thrust and Maximum Reverse thrust, and 1 minute Idle.
g. Thrust transients run - Thirty minutes of thrust transients, consisting of 6 cycles in the sequence of power lever postion from Idle thrust to Takeoff Augmented thrust, maintained at Takeoff Augmented for 60 ± 3 seconds, retarded to Idle, and maintained for approximately 4 minutes. One cycle will be accomplished with the augmentation lightoff at minimum augmented power lever position.
h. Incremental thrust run - One hour and 15 minutes consisting of 5 minutes with the power lever position corresponding to each of the following percentages of Takeoff Nonaugmented thrust: 15, 25, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 95, 100. This portion of the test may be revised to include additional time at the vibratory speeds and elimination of some intermediate points.

28.2.2.2.2.2 Part 2 - The 50-hour heated inlet air test shall be conducted on the engine which completed Part 1 above, without the reverser-suppressor installed. The test shall consist of 12 cycles of 4 hours and 10 minutes each to be conducted in accordance with the schedule listed below and as shown on figure A-2 (curve A). The engine inlet air and the air that passes over the engine will be conditioned as shown on figures A-2 (curve B), and A-3 (curve A) within the tolerances of the facility. The fuel temperature at the fuel pump inlet will be as shown on figure A-3 (curve B) within the tolerance of the facility. This portion of the Flight Test Status endurance test shall be conducted, within facility limitations, as follows:

a. Maximum Augmented thrust run - Seven minutes with the power lever position corresponding to the Maximum Augmented thrust position.
b. Maximum cruise thrust run - Twenty-four minutes with the power lever position corresponding to 55% of Maximum Augmented thrust.
c. Minimum Cruise thrust run - Twenty-four minutes with the power lever position corresponding to 40% of Maximum Augmented thrust.
d. Idle descent run - Sixteen minutes with the power lever in the Idle thrust position.

e. Airport departure maneuver, Cruise Part Power run - Fifteen minutes with the power lever position corresponding to 20% of Takeoff Nonaugmented thrust.
f. Maximum augmented thrust run - Thirteen minutes with the power lever position corresponding to the Maximum Augmented thrust position.
g. Maximum cruise thrust run - Fifty-five minutes with the power lever position corresponding to 55% of Maximum Augmented thrust.
h. Minimum cruise thrust run - Fifty-five minutes with the power lever position corresponding to 40% of Maximum Augmented thrust.
i. Subsonic cruise nonaugmented run - Twenty-five minutes with the power lever position corresponding to 50% of Takeoff Nonaugmented thrust.
j. Idle descent run - Sixteen minutes with the power lever in the Idle thrust position.

Two augmentation system lightoffs shall be made during each cycle.

28.2.2.2.2.3 Starts - A minimum of 25 sea level static starts shall be made on the endurance test engine. There shall be at least 10 starts each preceded by at least a 2-hour shutdown. At least one of these 10 starts shall be made during or at the beginning of each 2 successive cycles. In addition, there shall be 5 false starts (a starting sequence without benefit of ignition, followed immediately after the permissible engine drainage procedure by a successful start), and 5 restarts (a start within a maximum of 15 minutes time from shutdown). If necessary, additional starts required to bring the total to 25 may be made at the end of the endurance test. The false starts may be conducted on an outdoor test stand using an engine not necessarily the endurance test engine.

28.2.2.2.2.4 Altitude Test - An engine, substantially identical to but not necessarily the same engine which completed 28.2.2.2.2.1 and 28.2.2.2.2.2, shall be subjected to altitude tests to substantiate the altitude performance specified in table II as modified by 6.1 in Appendix A.

28.2.2.2.2.5 Data

28.2.2.2.2.5.1 Steady-State Data - During the endurance test, except for the thrust transient runs, the following data shall be recorded, where applicable, at intervals not greater than 30 minutes or once during each test run, whichever is shorter:

Time of day.
Total endurance time.
Power lever position.
Exhaust nozzle position.
Engine rotor speeds, rpm.
Fuel consumption, lb/hr.
*Data for determining airflow.
Engine inlet total pressure, in. Hg. abs.

Engine inlet total temperature, °F (°C).
*Compressor air bleed total pressure, psia.
Compressor air bleed static pressure, psia.
Turbine discharge total pressure, psia.
*Exhaust total pressure, psia.
Exhaust static pressure, in. Hg. abs (if different from the barometer readings).
Oil pressure at pressure pump outlet, psig.
Fuel pressure at fuel system inlet, psig.
Fuel pressure at point shown on Installation Drawing, psig.
Fuel temperature at fuel system inlet, °F (°C).
Measured steady-state turbine exhaust gas temperature, °F(°C).
Duct heater fuel flow, lb/hr.
Engine case vibration at points shown on Installation Drawing, mils.
*Ignition source voltage and current (while starting).
Engine Main Oil Temperature °F (°C).
Breather Pressure, psia.

*Note: Items marked with an asterisk need be recorded during calibrations only. The oil consumption, oil specific gravity, fuel specific gravity, and fuel lower heating value shall be measured at suitable intervals.

28.2.2.2.2.5.2 Thrust Transient Data - For each thrust transient performed during the thrust transient and reverse thrust runs, the maximum values of measured gas temperature, thrust, fuel flow, and engine speed attained during the thrust transients shall be recorded.

28.2.2.2.2.5.3 Starting Data - During the starts conducted under 28.2.2.2.2.3, the following data shall be recorded for each start performed:

Ambient temperature.
Start number.
*Time to ignition.
*Time to starter cut out.
Time to stabilize ground idle rpm.
*Rpm at ignition.
*Rpm at starter cut out.
Maximum measured gas temperature.

Note: Items marked with an asterisk need be recorded only during calibration, recalibration, and 2 successive starts at the beginning and the end of the endurance test, at least one of which will be after a 2-hour shutdown. These data will also be recorded during one of the false starts.

In addition, records of starter torque versus revolutions per minute (rpm) shall be made during calibration, recalibration and 5 successive starts of the endurance test. Starter torque versus rpm testing may be waived if acceptable data are available from another equivalent engine.

28.2.2.2.3 Recalibrations

28.2.2.2.3.1 Engine Recalibration - After completion of the tests specified in 28.2.2.2.2.1 and 28.2.2.2.2.2, a recalibration check run in accordance with 28.2.2.2.1.3 "a" and "b" as modified shall be made on the endurance test engine. During the recalibration check run, the engine shall be adjusted to produce on a standard day, the nonaugmented thrust or maximum turbine discharge temperature, whichever is lower, that was obtained during the initial calibration. During maximum augmented operation, duct heater fuel flow shall be adjusted so that, on a standard day, the total fuel flow will correspond to the level that was obtained during the initial calibration. During this run the corrected jet thrust shall be not less than 95% of the initial calibration values, and the corrected specific fuel consumptions shall not exceed 105% of the initial calibration values. The engine shall meet all other specified performance requirements which can be checked by the calibration procedure. The check run may be preceded by a run-in period during which the cleaning procedure recommended for field use by P&WA may be applied.

28.2.2.2.3.2 Engine Control System Recalibration - After completion of the engine recalibration specified in 28.2.2.2.3.1, the components of the engine control system shall undergo a bench recalibration to determine conformance with the design tolerance range required by P&WA. For this recalibration, external engine control adjustments shall be established at their pre-test bench calibration positions.

28.2.3 Engine Components Test - P&WA will supply suitable data on engine component tests. Components used for these tests shall be substantially identical with those used on the endurance tests. The instrumentation to be delivered with the FTS engine shall not be subject to FTS test approval.

28.2.4 Teardown Inspection - After completion of the tests, the engine and components shall be completely disassembled for examination of all parts and measured, as necessary, to disclose excessively worn, distorted, or weakened parts. These measurements shall be compared with the drawing dimensions and tolerances, or with similar measurements made prior to the test when available.

28.2.5 General Inspection - All tests shall be subject to witnessing by a Government representative. The engine and components shall be examined to determine if they conform to all requirements of the contract and specification under which they were built. At convenient times prior to the tests and during teardown inspections the engine and components shall be examined to determine if they conform to all requirements of the contract and specifications under which they were built. Inspection of the engine during the test may be conducted between the test cycles at the discretion of P&WA. External adjustments normally performed during routine maintenance may be made at the discretion of P&WA. Part changes may be made during the test provided that such part subsequently completes that portion of the test run prior to its installation. This requirement may be accomplished on the same engine or another engine assembled essentially to the same parts list. The Government representative shall be notified of any such maintenance, adjustment or parts change."

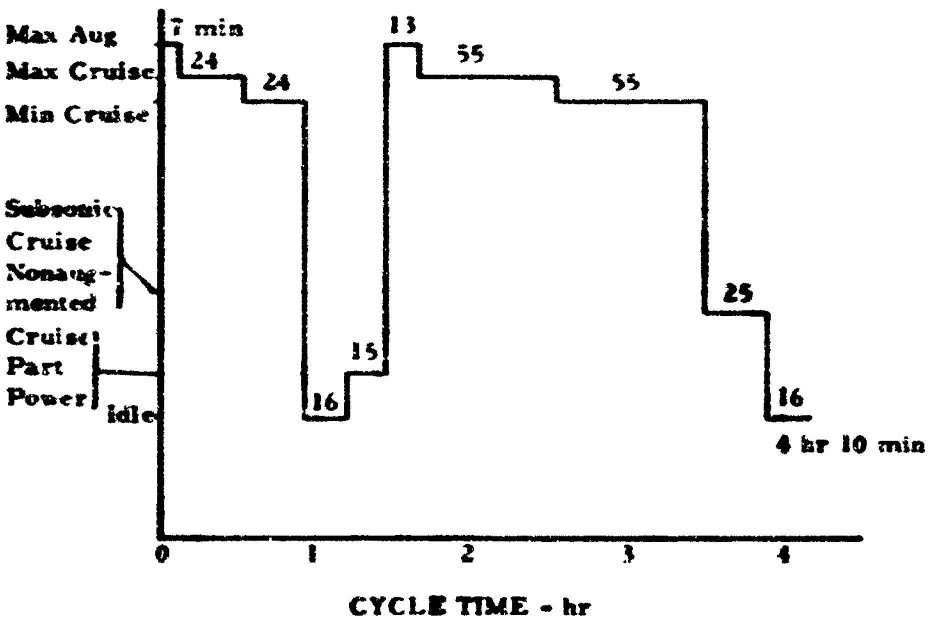
Figure A-1

JTF17A-21L TURBOFAN ENGINE
FTS SEA LEVEL ENDURANCE CYCLE

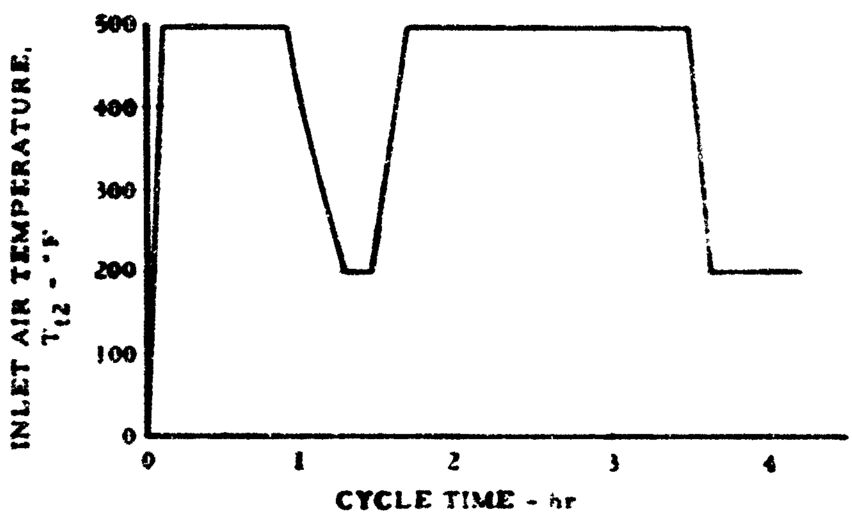
Figure A-2

JTF17A-21L TURBOFAN ENGINE
FTS HEATED INLET CYCLE

12 Cycles to be Run for a Total of 50 Hours.



A

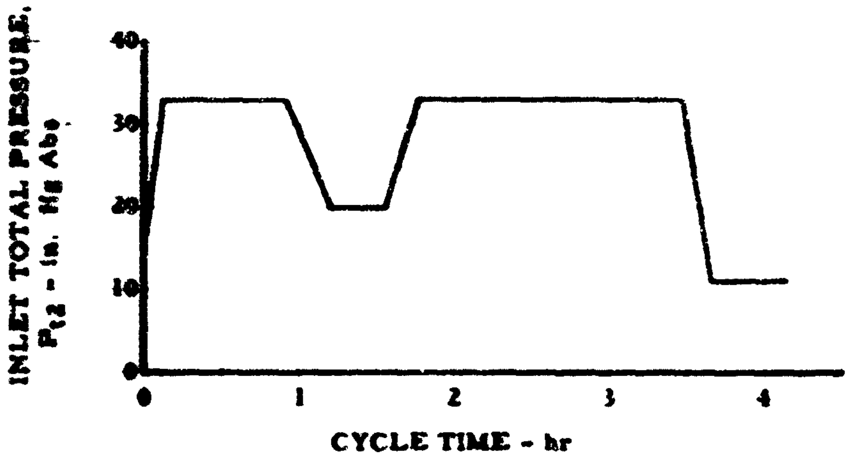


B

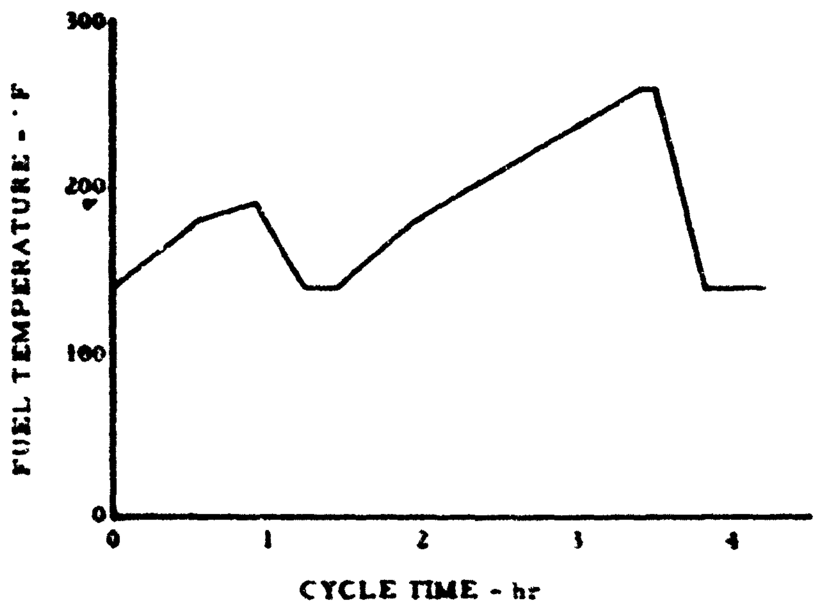
[illegible]-66

Figure A-3

JTF17A-21L TURBOFAN ENGINE
FTS HEATED INLET CYCLE



A



B

ENGINE INSTALLATION DRAWING
FOR JTF17A-21L PROTOTYPE
IDENTICAL TO 2128101 - SHEETS
1,2,3,4 - ENGINE INSTALLATION
JTF17A-21L PRODUCTION

AUGUST 8, 1966
PRELIMINARY
SUBJECT
TO
CHANGE

PRATT & WHITNEY AIRCRAFT
CONTROLLED

Pratt & Whitney Aircraft

ENGINE INSTALLATION (FTS)
(JTF17A-21L PROTOTYPE)

FIRST RELEASE ENGINE TYPE JTF17

FA-SS-66-8

CODE IDENT NO.	SIZE	
77445	A	2130201

ALLOWABLE LOADS DRAWING
FOR JTF17A-21L PROTOTYPE
IDENTICAL TO 2128090
ALLOWABLE LOAD INSTALLATION
JTF17A-21L PRODUCTION

AUGUST 8, 1966
PRELIMINARY
SUBJECT
TO
CHANGE

PRATT & WHITNEY AIRCRAFT
CONTROLLED

Pratt & Whitney Aircraft

LOAD INSTALLATION (FTS)
ALLOWABLE FLIGHT SHIPPING &
GROUND HANDLING
(JTF17A-21L PROTOTYPE)

FIRST RELEASE ENGINE TYPE JTF17

FA-SS-66-8

CODE IDENT NO.	SIZE	
77445	A	2130129

ELECTRICAL INSTALLATION DIAGRAM
FOR JTF17A-21L PROTOTYPE
IDENTICAL TO 2128103
ELECTRICAL INSTALLATION DIAGRAM
JTF17A-21L PRODUCTION

AUGUST 8, 1966
PRELIMINARY
SUBJECT
TO
CHANGE

PRATT & WHITNEY AIRCRAFT
CONTROLLED

Pratt & Whitney Aircraft

DIAGRAM-ELECTRICAL
INSTALLATION CONNECTION
(JTF17A-2L PROTOTYPE)

FA-SS-66-8

CODE IDENT NO	SIZE	
77445	A	2130203

ENGINE TYPE JTF17